UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2015 FULL YEAR COURSES EXAMS

POST GRADUATE

Course Code	Course Title
1. BIO 5102 - ----	Biosystematics of tropical animal Taxa
2. BIO 5122 - ----	Biodiversity Assessment and Management
3. BIO 5155 - ----	Aquatic Ecology and Fish population
4. BIO 5452 - ----	Biotechnology and Bio safety
5. BIO 5462 - ----	Computer Application to Molecular Biology
6. BIO 5482 - ----	Plant Development
7. CHE 5222 - ----	Electrochemical and Chromatography Methods
8. CHE 5435 - ----	Further Bio-inorganic chemistry
9. CS 5812 - ------	Data communication and Computer Networks
10.GES 5411 - ---	Research Methodology
11.GES 5422 - ---	Geographic information systems and Remote Sensing
12. GES 5625 - ---	Environmental Law
13. MAT 5041 - ---	Financial Mathematics
14. MAT 5652 - ---	Statistics in Epidemiology
15. MAT 5652 - ---	Econometrics
16. MAT 5662 - ---	Theory of Non-Parametric Statistics
17. MAT 5671 - ---	Probability and Mathematical Statistics

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5102: BIOSYSTEMATICS OF TROPICAL ANIMAL TAXA
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS: QUESTION **ONE** FROM EACH SECTION AND THE **FIFTH** QUESTION FROM ANY OTHER SECTION. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

SECTION A: Principles of Nomenclature

1. Discuss five basic tenets of the botanical, bacteriological and zoological codes of nomenclature and show how these are used to ensure that names given to organisms remain unambiguous, permanent and universal.

2. (a)Discuss five different concepts of species used in taxonomy today, highlighting shortcomings of each concept.
   (b) Explain why humans still use all the concepts when developing classifications of animals, despite the shortcomings.

SECTION B: Systematics of Invertebrates questions

3. Explain why Sponges (Order Porifera) are considered to be the most primitive invertebrates in existence today.

4. Discuss the characteristics of Arthropods in general and insects in particular which have made Arthropods the most successful animals in the biosphere today.

TURN OVER

SECTION C: Systematics of Terrestrial Vertebrates

5. Compare and contrast the main taxonomic characteristics of the amphibians and reptiles.

6. Describe each of the following:
   (a) Ophidia.
   (b) Pleuradira.

SECTION D: Systematics of Fishes

7. Discuss the significance of the dorsal fin in fish identification and description.
8. Compare and contrast characteristics of the families Mochokidae and Clariidae.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO5122: BIODIVERSITY ASSESSMENT AND MANAGEMENT
THEORY PAPER

TIME: THREE HOURS

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

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1. Discuss each of the following:
   (a) Ecosystem diversity.
   (b) Biodiversity assessment project logical framework.

2. Discuss evolutionary and ecological factors that have an influence on biodiversity of species.

3. Describe the procedure for preparing a biodiversity country profile and discuss assumptions and limitations associated with it.

4. Discuss each of the following:
   (a) Values and functions of biodiversity.
   (b) Limitations of the Shannon-Weiner Diversity index.

5. Discuss each of the following as it relates to community structure in space of biodiversity:
   (a) Ambient energy hypothesis.
   (b) Intermediate disturbance hypothesis.

6. Discuss views contradicting Connell and Orias (1964) productivity hypothesis that "greater production results in greater diversity, everything else being equal."

7. Discuss each of the following:
   (a) Stratified systematic sampling.
   (b) Point- centered quarter method.

8. Discuss any **two** of the following:
   (a) Threats to biodiversity in Zambia.
   (b) Protected Area System (PAS) in Zambia.
   (c) Biodiversity Convention (CBD).

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO5122: BIODIVERSITY ASSESSMENT AND MANAGEMENT
THEORY PAPER

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BIO5122: BIODIVERSITY ASSESSMENT AND MANAGEMENT
THEORY PAPER

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THE UNIVERSITY OF ZAMBIA
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2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5155: AQUATIC ECOLOGY AND FISH POPULATIONS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ANSWER **TWO QUESTIONS** FROM **EACH** SECTION AND A **FIFTH** QUESTION FROM **EITHER** SECTION. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

SECTION A: Aquatic Ecology

1. Explain how each of the following is used in the categorisation of aquatic ecosystems:
   (a) Concentration of dissolved ions.
   (b) Water currents.

2. (a) Discuss the types of ions that determine productivity of aquatic ecosystems.
   (b) Explain the relationship between conductivity and productivity of inland aquatic ecosystems.

3. (a) Summarise the factors that determine the amount of light available at the surface of a water body.
   (b) Describe three possible outcomes of light as it strikes a water column.
   (c) Explain the significance of Secchi disk measurements in determining productivity of water bodies.

4. Discuss the Redfield ratio focusing on its significance in the abundance of primary producers in aquatic ecosystems.

SECTION B: Fish Populations

5. Describe the type of data and a method required for estimating the following von-Bertalanffy (1936) growth parameters:
   (a) The growth coefficient (k).
   (b) Length at infinity (L_∞).

TURN OVER

6. Discuss the different models that show the relationships between parent stock size and number of recruits in fish populations.

7. Describe two methods that are commonly used to estimate mortality coefficients in fish populations.

8. (a) Explain the data required for estimating Maximum Sustainable Yield (MSY) when applying Surplus Production Models.
   (b) Compare and contrast the Schaefer and Fox Models, as applied in estimating the Maximum Sustainable Yields (MSY) and f_{msy} for fish stocks.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
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2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5155: AQUATIC ECOLOGY AND FISH POPULATIONS
THEORY PAPER

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2014 ACADEMIC YEAR
FINAL EXAMINATIONS

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2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5155: AQUATIC ECOLOGY AND FISH POPULATIONS
THEORY PAPER

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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5452: BIOTECHNOLOGY AND BIOSAFETY

THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ILLUSTRATE YOUR ANSWERS WHEREVER NECESSARY.

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1. Critically discuss each of the following:
   (a) Labelling of genetically modified organisms (GMOs)
   (b) Containment of genetically modified (GM) plants

2. (a) Discuss the advantages and disadvantages of Biotechnology.
   (b) Compare and contrast the Biosafety Policy frameworks of Zambia and South Africa.

3. Explain the Cartagena Protocol and the Nagoya Protocol as they relate to the World Trade Organization (WTO).

4. (a) Explain the principle of precautionary approach as enshrined in the Cartagena Protocol.
   (b) Distinguish between a living modified organism (LMO) and an LMO product.
   (c) Distinguish between parties and non-parties to the Cartagena Protocol.
   (d) Describe the procedure for moving LMOs across borders.

5. Discuss the quarantine levels required of the facilities dealing with GMOs.

6. (a) Describe the procedures for testing agricultural and manufactured food products for GMOs.
   (b) Describe the application and approval procedures for use of GMOs in Zambia.

7. (a) Explain the principles of biosafety communication.
   (b) Discuss the channels and tools used in biosafety communication.

8. (a) Explain the mechanism of resistance to 2,4D in GM cotton.
   (b) Explain the mechanism of resistance to insects in GM cotton.
   (c) Discuss the benefits and risks of GM cotton.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5452: BIOTECHNOLOGY AND BIOSAFETY

THEORY PAPER

TIME: THREE HOURS

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THE UNIVERSITY OF ZAMBIA
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2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5452: BIOTECHNOLOGY AND BIOSAFETY

THEORY PAPER

TIME: THREE HOURS

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THE UNIVERSITY OF ZAMBIA
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2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5452: BIOTECHNOLOGY AND BIOSAFETY

THEORY PAPER

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THE UNIVERSITY OF ZAMBIA
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2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5462: COMPUTER APPLICATION TO MOLECULAR BIOLOGY

THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS: **BOTH** QUESTIONS FROM SECTION A AND ANY **THREE** FROM SECTION B.

SECTION A

QUESTION I

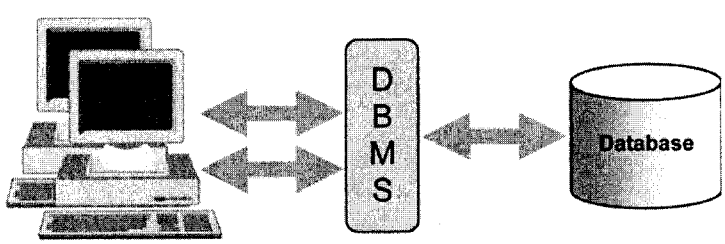
a) An Operating System is the core software that helps to run various programmes on the Hardware that makes up a Computer System. Linux operating system is such an example. List any four types of other operating system apart from Linux in use today.

b) Linux operating system is classified as open source.

   i. What is Open Source Software?
   ii. What are the advantages and disadvantages of open source software over closed source software?

c) Database Management System (DBMS) plays an important role in the implementation of bioinformatics databases. The diagram below shows the relationship between a database and the DBMS.

   i. What is a DBMS?
   ii. Give any two examples of the DBMS.
   iii. What is a database query?



d) Give a brief description of each of the following terms used in the design and implementation of databases.

i. Primary Key
ii. Attribute
iii. Entity
iv. Field
v. Record

Question II

a) Give a brief decription of each of the following Terms:

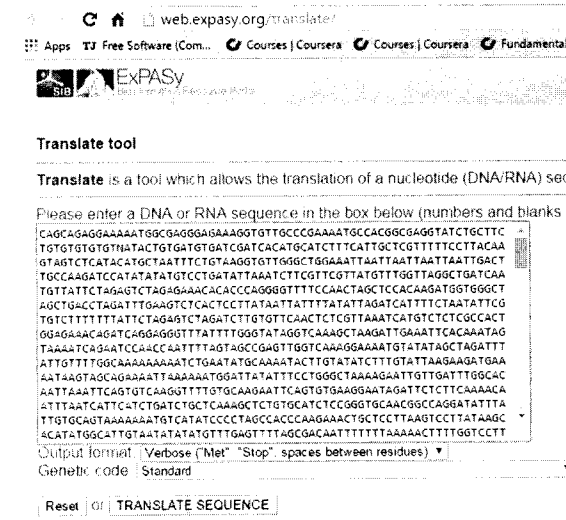
i. DNA Sequencing
ii. Base Pair (bp)
iii. Genome

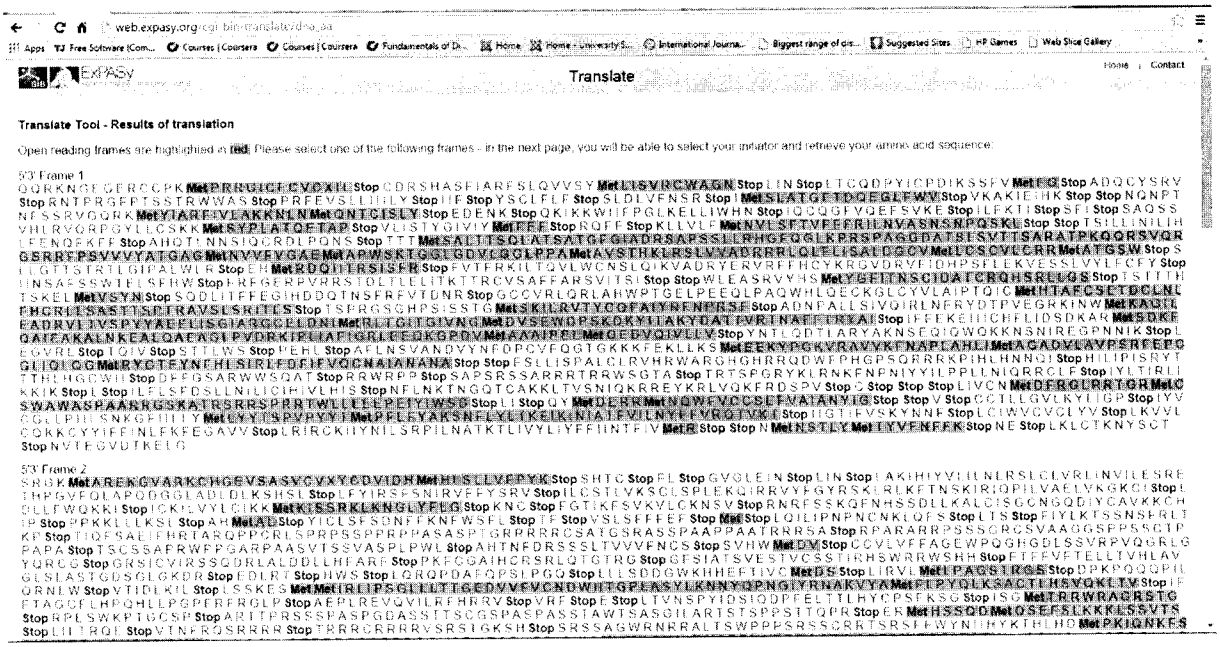
b) One of the tools used to convert the nucleotide to the corresponding amino acids is **ExPASy**. The diagrams below show the results generated by using the rice nucleotide sequence provided as an annex at the end of the examination. Using the results below, answer the following questions

i. What is a stop Codon?
ii. Identify the three stop condos in the **Genetic Code Table** Below.
iii. Explain why **ExPASy** Tool generates six Reading Frames instead one.
iv. The diagram below shows only two results of the **Reading Frames**. Using the Genetic Code below, Generate and write down the first 15 amino acids for each of the **remaining four Reading Frames** in addition to the two Reading Frames shown below as generated by ExPASy.

Table of Standard Genetic Code

	T	C	A	G
T	TTT Phe (F)	TCT Ser (S)	TAT Tyr (Y)	TGT Cys (C)
	TTC Phe (F)	TCC Ser (S)	TAC Tyr (Y)	TGC Cys (C)
	TTA Leu (L)	TCA Ser (S)	TAA Stop	TGA Stop
	TTG Leu (L)	TCG Ser (S)	TAG Stop	TGG Trp (W)
C	CTT Leu (L)	CCT Pro (P)	CAT His (H)	CGT Arg (R)
	CTC Leu (L)	CCC Pro (P)	CAC His (H)	CGC Arg (R)
	CTA Leu (L)	CCA Pro (P)	CAA Gln (Q)	CGA Arg (R)
	CTG Leu (L)	CCG Pro (P)	CAG Gln (Q)	CGG Arg (R)
A	ATT Ile (I)	ACT Thr (T)	AAT Asn (N)	AGT Ser (S)
	ATC Ile (I)	ACC Thr (T)	AAC Asn (N)	AGC Ser (S)
	ATA Ile (I)	ACA Thr (T)	AAA Lys (K)	AGA Arg (R)
	ATG Met (M)	ACG Thr (T)	AAG Lys (K)	AGG Arg (R)
G	GTT Val (V)	GCT Ala (A)	GAT Asp (D)	GGT Gly (G)
	GTC Val (V)	GCC Ala (A)	GAC Asp (D)	GGC Gly (G)
	GTA Val (V)	GCA Ala (A)	GAA Glu (E)	GGA Gly (G)
	GTG Val (V)	GCG Ala (A)	GAG Glu (E)	GGG Gly (G)





SECTION B

Question III

c) With the aid of a diagram give a brief description each of the following terms:

i. A Nucleotide

ii. Gene

iii. Chromosome

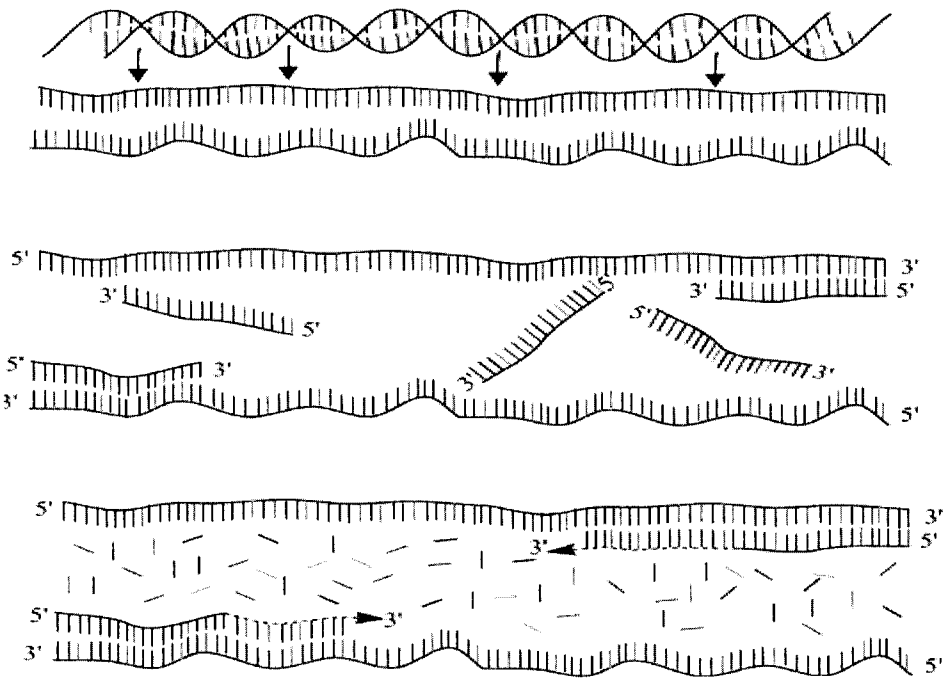
iv. DNA

v. Codon

d) One of the most important stages in the Gene Sequencing is the Polymerase Chain Reaction (PCR) used in performing the Wet-Lab experiment. Briefly describe the PCR process by making reference to the following:

i. Components of PCR Reaction

ii. Variables such as Temperature, Cycle Times and Numbers, Primer, Buffer and Polymerase



Question IV

a) Define each of the following Terminologies in relation to blast:

i. Query Sequence

ii. Subject Sequences

b) Munsaka, a postgraduate student has successfully completed a Wet Lab for sequencing the Mongu Rice. The end product of the experiemnet was the nucleotide provided on the separate sheet of paper. Munsaka then used NCBI to Blast the nucleotide. The diagrams below show the sequence followed by Munsaka. Using the results generated below.

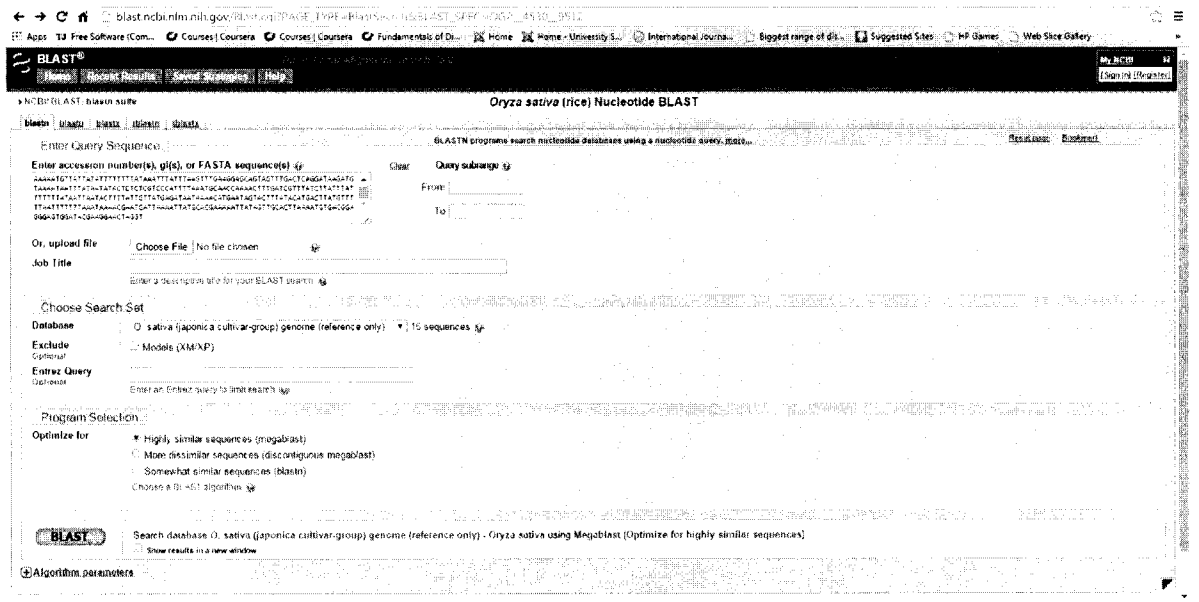
i. Name the two chromosome identified by the nucleotide Blast.

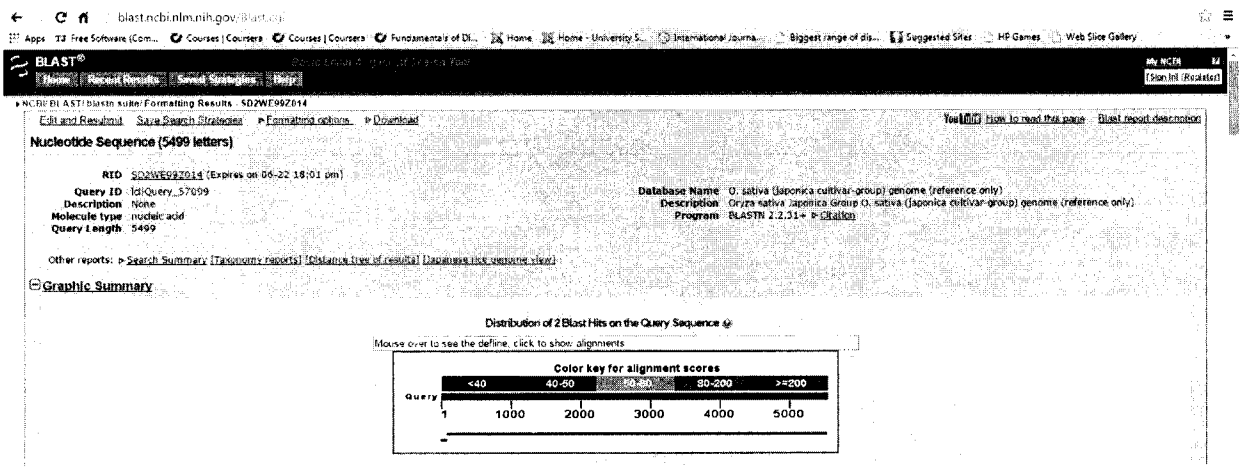
ii. What is the likely identity of the gene in the sequence above.

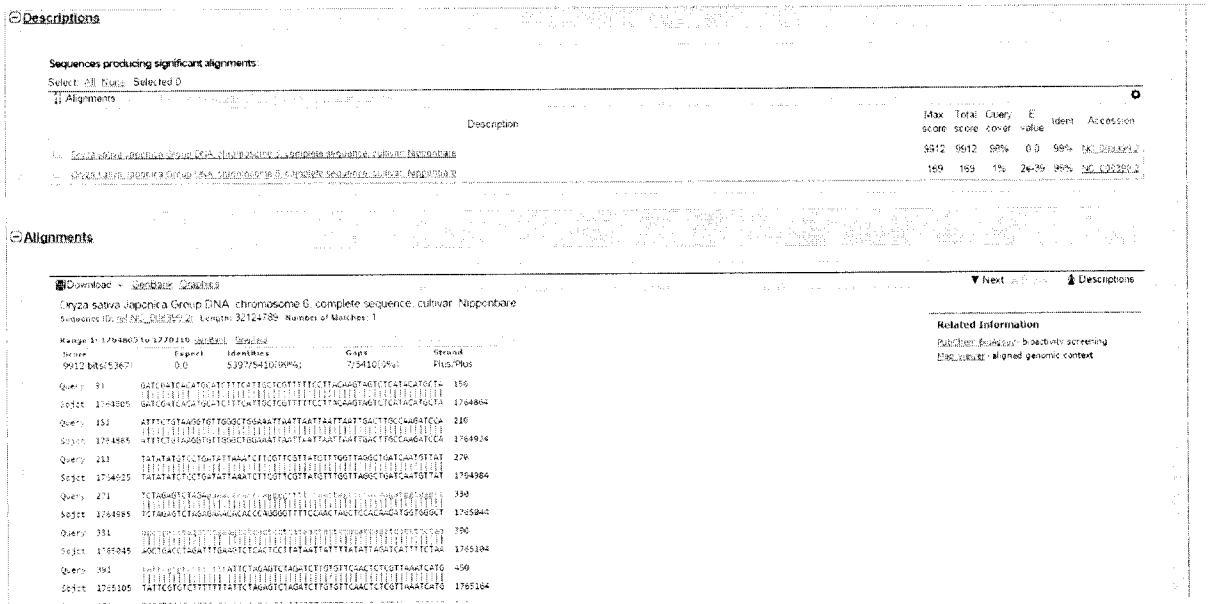
iii. Outline the basic steps that are needed to generate the results shown below.

iv. What do the following parameters mean in relation to the results generated shown below:

1. Identities
2. Gaps
3. Score
4. Expect (E)





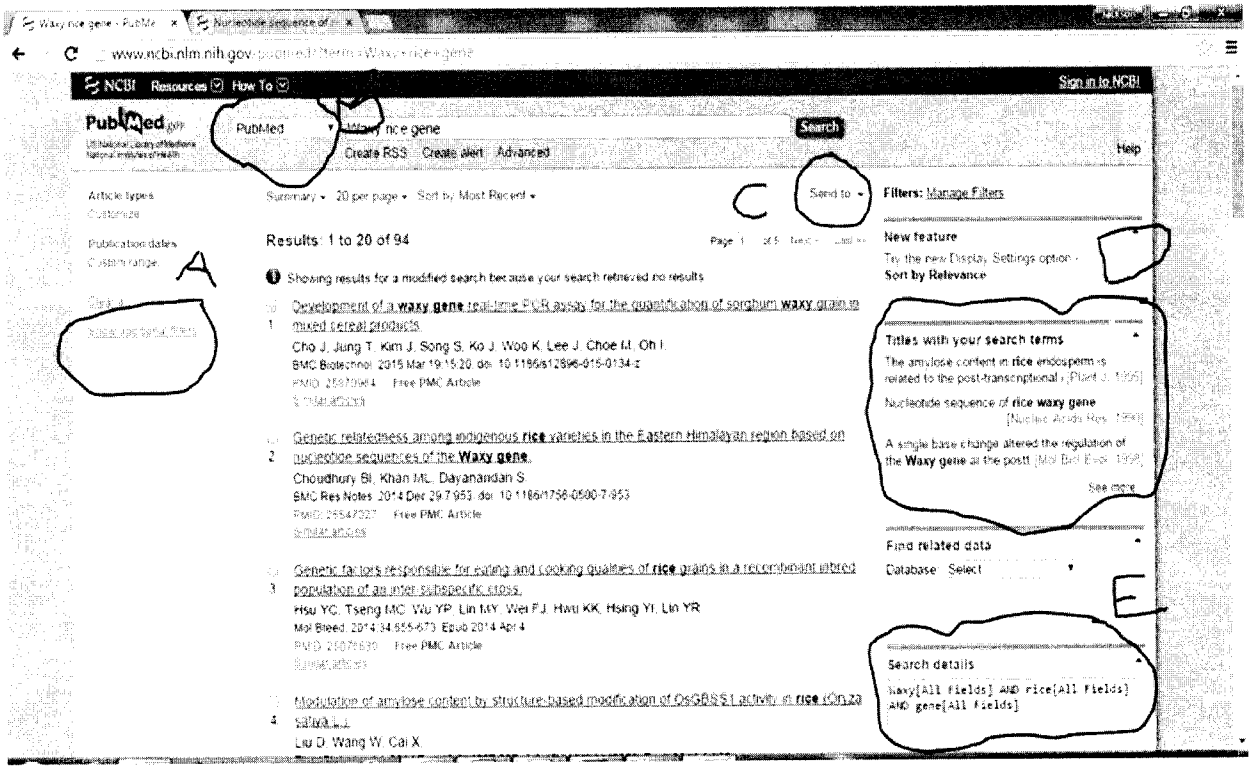


Question V

a) Give a brief description of each of the following Databases used in Bioinformatics:
   i. BioProject (Genome Project)
   ii. Gene

b) With the aid of the diagram, describe an Open Reading Frame (ORF).

c) The diagram below shows the search results using the PubMed website from NCBI Home page.
   i. What do the letters NCBI stand for?
   ii. Define and give a brief description of the PubMed Database.
   iii. Briefly describe the function of the fields marked (A), (B), (C), (D) and (E) in the diagram below in relation to the search in PubMed Database.
   iv. Using the diagram below, explain how you may go about to search for articles using the author name or using the key words for the Waxy Gene published in the last five(5) years and written in English only.



QUESTION VI

a) Give the LINUX command that would enable you to accomplish the following tasks using Ubuntu Operating System command line.

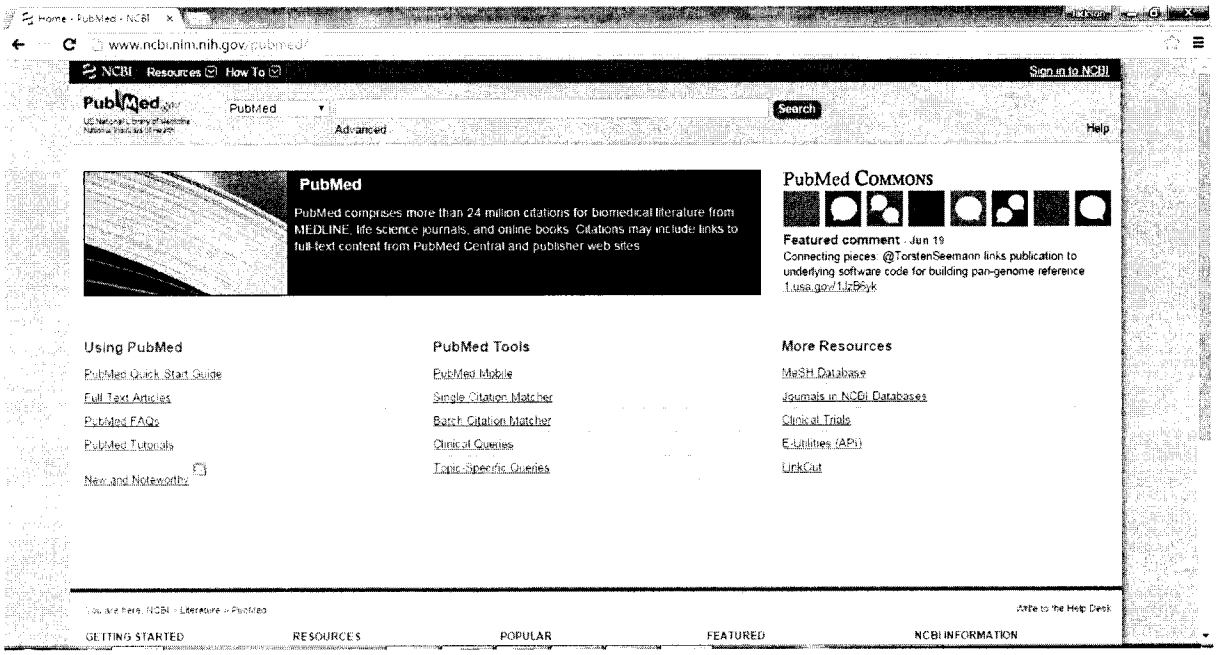
i. Listing Files in the bin director
ii. Creating a directory in your Home directory called Assignments

b) Give a brief description of each of the following Bioinformatics Databases.

i. GenBank
ii. Assembly
iii. BioSystems
iv. Bookshelf

c) The diagram below show the NCBI website. Give a brief description of each of the following variants of Blast and where it can be used:

i. BLASTP
ii. BLASTN
iii. BLASTX
iv. TBLASTN



ANNEX: RICE NUCLEOTIDE

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END OF THE EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5482: PLANT DEVELOPMENT
THEORY PAPER

TIME: THREE HOURS

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

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1. Discuss the application of random mutagenesis and reporter genes in the analysis of plant developmental processes.

2. Discuss the molecular genetics of dorso-ventral and 2-dimensional leaf development.

3. Discuss each of the following:
   (a) The role of pollen-expressed genes in early embryogenesis.
   (b) The roles of *WUSCHEL (WUS)*, *SHOOT MERISTEMLESS (STM)* and *CLAVATA (CLV)* genes in shoot meristem maintenance.

4. Explain the roles of micro RNAs and trans-acting small interfering RNAs in two plant developmental processes.

5. Discuss the molecular control of photomorphogenesis and how some of the genes involved in skotomorphogenesis are analyzed.

6. (a) Discuss the florigen concept proposed in the 1930s by the Russian physiologist Dimitri Chailakyan, explaining why it has not been demonstrated.

   (b) Describe the alternative theories that have been proposed to explain the molecular control of flowering.

7. State the four different pathways that control flowering in flowering plants and discuss the common and different genetic controllers of two of the four flowering pathways.

TURN OVER

8. Discuss embryogenesis in plants and explain the roles of *LEAFY COTYLEDON I* (*LEC1*) and *BABY BOOM* (*BBM*) in embryogenesis in plants.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2014/2015 ACADEMIC YEAR END OF YEAR EXAMINATIONS

CHE 5222 ELECTROCHEMICAL AND CHROMATOGRAPHIC METHODS

TIME: **THREE HOURS**

INSTRUCTIONS

1 There are **Five** questions in this Examination Paper.

2 Answer **Question 1** and any other **THREE** questions.

3 Question 1 carries 25 marks and the remaining questions carry equal marks.

4 **Each question** should be answered in a **separate** answer **booklet.**

5 Essential information and data are provided for this paper

Question 1

(a) An MSc student studying a certain known compound determined its melting using DSC and found values that were slightly elevated. What could be the possible explanation for such values? **[5 marks]**

(b) Explain in brief the physical limitation of the heating process in thermal analysis. **[5marks]**

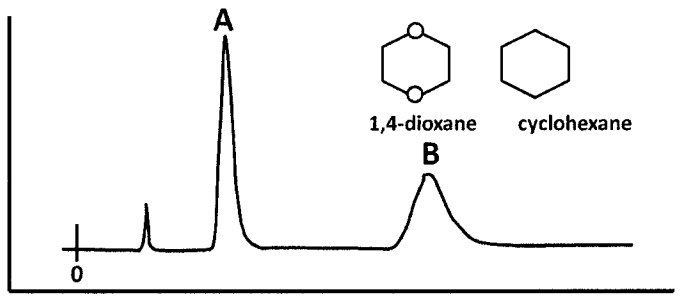
(c) Explain why differential pulsed polarography (DPP) gives superior detection limits to sampled-dc polarography. **[5marks]**

(d) Write a note on ion exchange chromatography with examples of the exchanger in each case. **[5 marks]**

(e) The four sources of instrumental noise are Thermal Noise, Shot Noise, Flicker Noise, and Environmental noise. Briefly discuss the differences between these kinds of noise, how they are different from each other, and how you can try to minimize each of these types of noise. **[5 marks]**

Question 2

Use the following gas chromatogram of a mixture of cyclohexane and 1,4-dioxane separated on a non-polar column to answer the following questions



(a) **What** is the identity of the substance labeled peak A? **Explain** how you deduced this. **[6 marks]**

(b) The area measured for peak A is 2 cm^2 and the area measured for peak B is 3 cm^2. Assuming that the detector response is the same for both substances, **calculate** the mol% of A in the mixture. **[8 marks]**

(c)The following questions are based on the van Deemter equation

(i) State the van Deemter equation clearly describing each variable in the equation. **[6 marks]**

(ii) A column in the GC-MS instrument has been standardized for the following constants, A=0.01 cm, B=0.30 cm^2/s and C=0.015 s. What is the minimum plate height (H) if the maximal flow rate (μ) is given by the equation

$$\mu_{max} = \sqrt{\frac{B}{C}}$$

[5 marks]

Question 3

(a) Compare and contrast the differences in theory of operation and equipment needed for potetiometric and voltammetric measurements. List any theoretical expressions that relate activity or concentration of an analyte to a measured electrochemical signal. **[8 marks]**

(b) The use of tuned amplification in analytical instrumentation is a very powerful method of S/N enhancement. Outline the processes involved in this technique and explain **HOW** S/N is improved. You should illustrate your answer with a noise power versus frequency plot which diagrams the steps involved in the process. **[8marks]**

(c) Anodic Stripping Voltammetry (ASV) has the best detection limits of any voltammetric methods available today. Briefly outline the steps involved in an ASV analysis and indicate why it has detection limits superior to the other Electrochemical methods we covered. **[10marks]**

Question 4

(a) (i) List and briefly explain the advantages and limitations of cyclic voltammetry. **[4 marks]**

(ii) Explain why differential pulsed polarography (DPP) gives superior detection limits to sampled-dc polarography. **[5marks]**

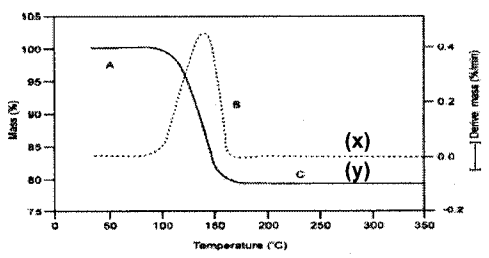
(b) Explain how diffusion-controlled mass transport of oxidized species to the electrode surface is ensured in hydrodynamic voltammetry, even though the solution is stirred. **[6marks]**

(c) Explain using examples why electrochemistry is well suited for chemical and biochemical sensing applications. What types of sensors have been developed? What are their advantages and special features? **[10 marks]**

Question 5

(a) Why is atmosphere control a critical factor in TGA and not in DTA? **[4 marks]**

(b) The diagram below shows two types of curves that are commonly used in TGA.



(i) Explain the difference and significance (if any) for the curves (x) and (y). **[2 marks]**

(ii) Describe the characteristics of the curve in the regions A, B and C. **[3marks]**

(iii) A sample containing a mixture of $CaCO_3$ and CaO was analyzed using TGA technique. A change in mass occurred in the region 500 – 900 °C from 145 mg to 115.4 mg. What percentage of $CaCO_3$ was in the sample? **[4 marks]**

(c) Explain in brief the working principle of a differential scanning calorimeter. **[5marks]**

(d) The choice of DSC pan is an important aspect towards obtaining good and consistent results. Explain the significance of the encapsulation. **[7 marks]**

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
				KEY													
				Atomic number **X** Atomic mass Name of the element X													
1 **H** 1.01 Hydrogen																1 **H** 1.01 Hydrogen	2 **He** 4.00 Helium
3 **Li** 6.94 Lithium	4 **Be** 9.01 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 23.00 Sodium	12 **Mg** 24.31 magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.99 Phosphorus	16 **S** 32.07 Sulphur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.55 Copper	30 **Zn** 65.39 Zinc	31 **Ga** 69.72 Gallium	32 **Ge** 71.61 Germanium	33 **As** 74.92 Arsenic	34 **Se** 78.96 Selenium	35 **Br** 79.90 Bromine	36 **Kr** 83.80 Krypton
37 **Rb** 85.47 Rubidium	38 **Sr** 87.62 Strontium	39 **Y** 88.91 Yttrium	40 **Zr** 91.22 Zirconium	41 **Nb** 92.91 Niobium	42 **Mo** 95.94 Molybdenum	43 **Tc** 97.91 Technetium	44 **Ru** 101.07 Ruthenium	45 **Rh** 102.91 Rhodium	46 **Pd** 106.42 Palladium	47 **Ag** 107.87 Silver	48 **Cd** 112.41 Cadmium	49 **In** 114.82 Inidum	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

THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Final Examination, 2015

CHE5435 Further Bio-Inorganic Chemistry

Time: 3 Hours **June 2015**

Instructions:

Answer any Four (4) Questions.
Show clarity in your answering.

Question 1

Carefully study the diagram in Fig 1. The diagram depicts the dioxygen uptake in humans.

(i) What mode of dioxygen bonding is illustrated in the Fig?

(ii) What features are noted before and after bonding?

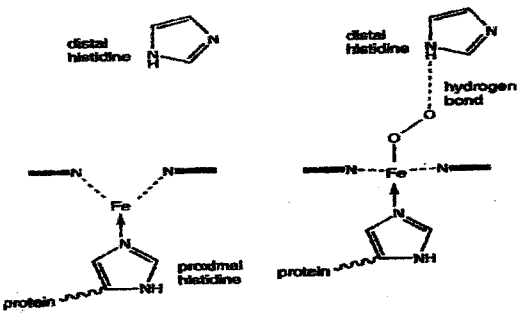


Fig 1.

(iii) How does Pauling account and justify for his concept of the dioxygen bonding?

Question 2

(a) Explain the terms: (i) apo-enzyme, (ii) cofactor

(b) Methylcobalamin is the form of vitamin B12 labelled in Fig 2 is "**Life Extension**". By clearly, demonstrating the essential reactions and their importance, show justification for the label?

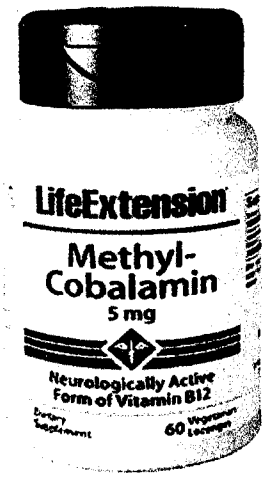
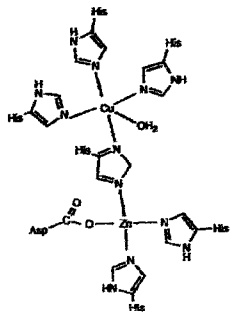


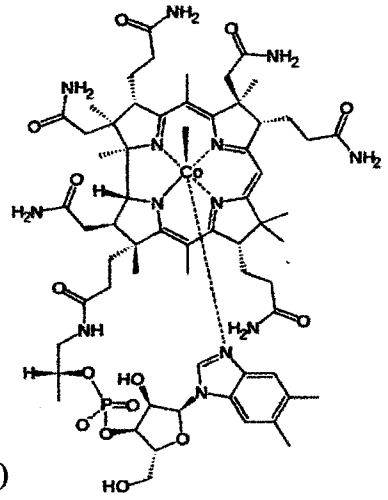
Fig 2

Question 3

Study the structures below:

(a)





(b)

(i) Briefly discribe (a) stating its use.
(ii) Discribe the role of (b) in biomethylation of mercury and how thie challenge could be combated.

Question 4

(a) Iron-Sulfur proteins come in varying forms. Suggest shorthand notation the bacteria-type protein in the Fig 3. Explain.

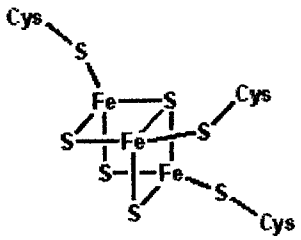


Fig 3

(b) Name three reactions which require Iron-Sulfur proteins in order to take place.

(c) One group of ferredoxins, originally found in Chloroplast membranes, has been termed "chloroplast-type" or "plant-type". The active centre is a $[Fe_2S_2]$ cluster. Describe its structure and its use.

Question 5

(a) Distinguish, with examples, the three types of 'blue' copper proteins indicating the *structure, characteristics, and function* of each type..

(b) State type of defect arising from copper deficiencies in animals and/or in man. Fully account for one of these deficiencies.

(c) Draw three structures of *mono*nuclear compounds essential for superoxide dismutase reaction.

END OF EXAMINATION

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.01 Hydrogen																1 **H** 1.01 Hydrogen	2 **He** 4.00 Helium
3 **Li** 6.94 Lithium	4 **Be** 9.01 Beryllium											5 **B** 10.81 Boron	6 **C** 12.01 Carbon	7 **N** 14.01 Nitrogen	8 **O** 16.00 Oxygen	9 **F** 19.00 Fluorine	10 **Ne** 20.18 Neon
11 **Na** 23.00 Sodium	12 **Mg** 24.31 magnesium											13 **Al** 26.98 Aluminium	14 **Si** 28.09 Silicon	15 **P** 30.99 Phosphorus	16 **S** 32.07 Sulphur	17 **Cl** 35.45 Chlorine	18 **Ar** 39.95 Argon
19 **K** 39.10 Potassium	20 **Ca** 40.08 Calcium	21 **Sc** 44.96 Scandium	22 **Ti** 47.88 Titanium	23 **V** 50.94 Vanadium	24 **Cr** 52.00 Chromium	25 **Mn** 54.94 Manganese	26 **Fe** 55.85 Iron	27 **Co** 58.93 Cobalt	28 **Ni** 58.69 Nickel	29 **Cu** 63.65 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 Inidum	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									

KEY

Atomic number

X

Atomic mass

Name of the element X

57 **La** 138.91 Lanthanum	58 **Ce** 140.12 Cerium	59 **Pr** 140.91 Praseodymium	60 **Nd** 144.24 Neodymium	61 **Pm** 144.91 Promethium	62 **Sm** 150.36 Samarium	63 **Eu** 151.97 Europium	64 **Gd** 157.25 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
Department of Computer Science

FINAL EXAMINATION

CSC 5812 DATA COMMUNICATION AND COMPUTER NETWORKS

Date:	26th JUNE 2015
Time:	09:00hrs – 12:00hrs
Duration:	3 Hours
Venue:	Hardware Lab

Instructions

1. There are five (5) questions and **two (2) sections** in this paper.
2. *Answer all the questions in Section A* and choose *any two (2) question from Section B*

SECTION A

ANSWER ALL THE QUESTIONS IN THIS SECTION

Q. 1

a) You can direct connect a desktop computer to another desktop computer using a cable. Name the type of the cable that you can use? (2 marks)
b) Define computer network. (1 mark)
c) If the period is 20s then what is the frequency? (2 marks)
d) What is Fourier analysis? (1 marks)
e) Differentiate Connection-oriented from connectionless service. (2 marks)
f) What is Network neutrality? (2 marks)
g) List three types of antennas. (3 marks)
h) If a signal does not change, what happens to its frequency? (1 mark)
i) Differentiate computer network from distributed system. (1 mark)
j) There are many computers on the network and every layer needs a mechanism for identifying the senders and receivers that are involved in a particular message. Name this mechanism. (3 marks)
k) List any two protocols that are in the application layer. (2 marks)

Total Marks 20

Q. 2

a) You can connect a desktop computer to a switch using a cable. Name the type of the cable that you can use? (2 marks)
b) Define Frequency. (1 mark)
c) What are transponders? (1 mark)
d) How is Frequency related to period? (1 marks)
e) Differentiate Analog and Digital Data. (1 mark)
f) Define Phase. (1 marks)
g) Differentiate periodic from non periodic. (1 mark)
h) The period of a signal is 100 ms, what is its frequency in kilohertz? (2 marks)
i) What is a client / server model? (2 marks)
j) List the three service primitives that provide a simple connection-oriented service. (3 marks)
k) There are three types of transmission technology. Name them. (3 marks)
l) List two protocols that are in the transport layer. (2 marks)

Total Marks 20

SECTION B

ANSWER ANY TWO (2) QUESTIONS IN THIS SECTION

Q. 3

a) Wireless is inherently a broadcast medium. 802.11 radios also have to deal with the problem that multiple transmissions that are sent at the same time will collide, which may interfere with reception. How does wireless solve this problem? (3 marks)
b) Explain in detail on magnetic media. (4 marks)
c) If a signal changes instantaneously, what happens to its frequency? (3 marks)
d) Explain in detail on Coaxial Cable. (4 marks)
e) Illustrate the client-server model. (4 marks)
f) Illustrate the OSI Model. (4 marks)
g) Explain in detail on twisted pair cable. (4 marks)
h) Compare wireless to fiber optics. (4 marks)

Total Marks 30

Q. 4

a) Wireless transmissions are broadcast therefore it is easy for nearby computers to receive packets of information that were not intended for them. How does wireless solves this problem? (4 marks)
b) Explain in detail on Fiber Optics. (4 marks)
c) Describe the relationship of Services to Protocols. (4 marks)
d) Illustrate the TCP/IP Model. (4 marks)
e) The OSI model has seven layers. List the three principles that were applied to arrive at the seven layers. (3 marks)
f) Explain in detail the politics of the Electromagnetic Spectrum. (4 marks)
g) Explain why we have protocol hierarchies? (3 marks)
h) Discuss peer-to-peer communication. (4 marks)

Total Marks 30

Q. 5

a) When a mobile client is moved away from the access point he/she is using into the range of a different access point, some way of handing it off is needed. What is the way? (3 marks)

b) Briefly discuss the OSI Reference Model. (4 marks)
c) The OSI model has seven layers. List the principles that were applied to arrive at the seven layers. (3 marks)
d) Explain in detail the uses of computer network. (4 marks)
e) Discuss the classification of Networks. (4 marks)
f) What led to the development of CAPTCHAs? (4 marks)
g) Explain in detail design Issues for the Layers. (4 marks)
h) Explain in detail RFID (Radio Frequency Identification) and Sensor network. (4 marks)

Total Marks 30

THE END

The University of Zambia

School of Natural Sciences

Department of Computer Studies

MSc Computer Science

Advanced Distributed Systems Examination August 2015

Section A: Attempt ALL Questions in this section

1. (a) Define what a transaction is. Be sure to give an example

(5 marks)

(b) A transaction is supposed to satisfy the so called ACID properties. Explain what the ACID properties are.

(20 marks)

2. (a) With the help of suitable examples, describe the client server paradigm.

(5 marks)

(b) Describe what a remote procedure call is. Using database links in Oracle as an example, describe in detail the implementation on both the client and server side of a client-server system.

(7 marks)

(c) Give two examples of where replication could be used in a distributed system, and explain in each case why replication is a good thing.

(8 marks)

(d) What is middle-ware in a distributed system and why is it used?

(5 marks)

Section B: Answer any TWO Questions from the given THREE.

3. (a) Define what an interleaving of two transactions is.

(2 marks).

(b) Define what it means for the interleaving of two transactions to be serially equivalent or serializable.

(3 marks).

(c) Give examples, and explain why it is necessary to require serially equivalent interleaving of transactions.

(5 marks)

(d) Lamport timestamps can be used for concurrency control of parallel transactions. Describe an algorithm and argue for its correctness.

(15 marks)

4. (a) Explain at least three(3) different types of transparencies that are desirable in a distributed system.

(9 marks)

(b) Explain the two phase commit algorithm or protocol. You should give the algorithms that the server and the clients implement, and explain what happens.

(10 marks)

(c) Suppose the server crashes during the two-phase commit algorithm. Explain if it is possible and how the clients can come to an agreement.

(5 marks)

5. Consider the following **Global Schema**:-

DOCTOR (*Dnum, Name, Department, Grade, TaxCode, Salary*)
PATIENT (*Pnum, Name, Treatment, Dnum*)
CARE (*Pnum, Drug, DatePrescribed, Quantity*)

DOCTOR has a horizontal fragmentation by Department where department is *Surgery* or department is *Pediatrics*

PATIENT has a derived horizontal fragmentation by Department.

PATIENTS who are in the *Surgery* department are further fragmented by treatment being *intensive*.

DOCTOR is vertically fragmented as follows:
Fragment 1: Staff (Dnum, Name, Department, Grade)
Fragment 2: Salary (Dnum, TaxCode, Salary)

(a) Give a complete minimal set of predicates to support the horizontal fragmentation strategy.

(8 marks)

(b) Write SQL code for creating all fragments.

(12 marks)

(c) Explain how the fragmentation strategy adheres to the rules of completeness, disjointness, and reconstruction.

Show how you would reconstruct the original tables.

(5 marks)

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR FINAL EXAMINATIONS

GES 5411: RESEARCH METHODOLOGY

TIME: Three hours

Instructions: Answer at least one question from section A and any other three. All questions carry equal marks. Use of an approved calculator is allowed. Critical tables are provided.

SECTION A

1. A researcher wanted to establish if there were differences in the mean Zinc concentrations (in mg/L) at the surface of the river and at the bottom. She randomly selected ten (10) sampling points and collected two samples from each point, at the surface and at the bottom of the river respectively, as shown in Table 1.

   Table 1. Zinc concentration levels in a river

Sampling point	Surface	Bottom
1	2.3	1.9
2	2.6	2.3
3	3.1	2.8
4	2.9	2.5
5	5.4	4.7
6	6.2	5.3
7	4.8	3.6
8	3.7	2.6
9	2.8	1.9
10	3.2	3.0

   Source: Hypothetical

   Using a confidence level of 95%, what conclusion could she draw from these results?

2. Sitko (2011) asserted that groundnuts were a woman's crop, because they were mostly cultivated by female farmers for home consumption rather than for sale. However, when grown in large quantities even female farmers sold off the excess. A study tracked the amount of groundnuts which were produced in Southern Province over the period 1976 to 2014 and the amounts sold over the same period. The objective of the study was to ascertain how annual groundnut production affected sales. Analyses were done at 95% confidence level and results were generated in SPSS as shown in Table 2. Study Table 2 and answer the following questions.

Table 2 Regression results

Regression

[DataSet1]

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Groundnuts Produced[b]	.	Enter

a. Dependent Variable: Groundnuts Sold(MT)

b. All requested variables entered.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.439[a]	.193	.169	298.7202	1.978

a. Predictors: (Constant), Groundnuts Produced

b. Dependent Variable: Groundnuts Sold(MT)

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	726327.964	1	726327.964	8.140	.007[b]
	Residual	3033946.832	34	89233.730		
	Total	3760274.796	35			

a. Dependent Variable: Groundnuts Sold(MT)

b. Predictors: (Constant), Groundnuts Produced

a) Formulate the hypotheses.

b) Interpret the P-value.

c) What does the coefficient of determination mean in this case?

d) Assuming the regression model linking groundnuts produced with groundnuts sold is $Y = 0.101 X + 74.17$

   i) Explain the slope of the equation.

   ii) A yield predictor model estimates that 642.2 MT of groundnuts will be produced in 2020. How much of the produce is expected to be sold in 2020?

SECTION B

3. Explain five purposes of having a good research proposal prior to conducting a research.
4. Discuss the assertion that 'observance of ethical considerations is mandatory when conducting research'.
5. Explain the concepts of ontology and epistemology, and show how they influence research methods.
6. Discuss the following sampling approaches
    a. Probability sampling
    b. Non probability sampling

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014 ACADEMIC YEAR FINAL EXAMINATIONS
GES 5422: GEOGRAPHIC INFORMATION SYSTEMS & REMOTE SENSING

TIME: Three hours

INSTRUCTIONS: Answer any FOUR questions
All questions carry equal marks

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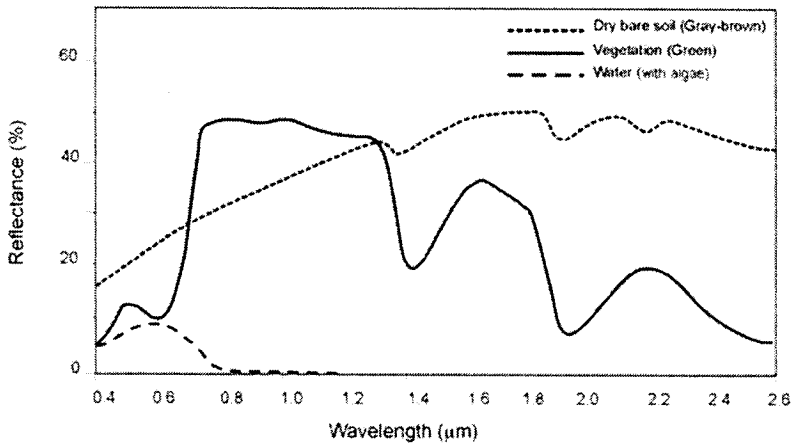
1. Write short explanatory notes for each of the following:
   a) Atmospheric window
   b) Spatial verses Temporal resolution
   c) Advantages and disadvantages of active sensors
   d) Geometric correction
   e) Spontaneous recognition and Logical Inference
   f) Raster verses Vector
   g) Forward and Inverse Mapping equations
   h) Mapping Socio-economic data
   i) Data integration
   j) Time series and climate change

2. Figure 1 shows the spectral reflectance curve of soil, vegetation and water. Explain the significance of the spectral reflectance curve as shown in the figure.

Fig. 1: Spectral Reflectance Curve



Source: https://www.google.co.zm/search?q=spectral+reflectance+curve

3. Identify an environmental problem and show how Remote Sensing and GIS can be used to deal with it.

4. Using examples, explain how in-situ and remote sensing methods can complement each other.

5. Compare and contrast Visual Image Interpretation (VII) and Digital Image Interpretation (DII).

6. Explain how data from Sun-synchronous orbiting satellites can be used in addressing climate change.

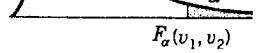
END OF EXAMINATION

Critical Values of Student's t

Degrees of freedom	Significance level (one-tailed)				
	0.05	0.025	0.01	0.005	0.0005
	Significance level (two-tailed)				
	0.1	0.05	0.02	0.01	0.001
1	6.31	12.71	31.82	63.66	636.62
2	2.92	4.30	6.97	9.93	31.60
3	2.35	3.18	4.54	5.84	12.92
4	2.13	2.78	3.75	4.60	8.61
5	2.01	2.57	3.37	4.03	6.86
6	1.94	2.45	3.14	3.71	5.96
7	1.89	2.37	3.00	3.50	5.41
8	1.86	2.31	2.90	3.35	5.04
9	1.83	2.26	2.82	3.25	4.78
10	1.81	2.23	2.76	3.17	4.59
11	1.80	2.20	2.72	3.11	4.44
12	1.78	2.18	2.68	3.05	4.32
13	1.77	2.16	2.65	3.01	4.22
14	1.76	2.15	2.62	2.98	4.14
15	1.75	2.13	2.60	2.95	4.07
16	1.75	2.12	2.58	2.92	4.01
17	1.74	2.11	2.57	2.90	3.97
18	1.73	2.10	2.55	2.88	3.92
19	1.73	2.09	2.54	2.86	3.88
20	1.73	2.09	2.53	2.85	3.85
21	1.72	2.08	2.52	2.83	3.82
22	1.72	2.07	2.51	2.82	3.79
23	1.71	2.07	2.50	2.81	3.77
24	1.71	2.06	2.49	2.80	3.75
25	1.71	2.06	2.49	2.79	3.73
26	1.71	2.06	2.48	2.78	3.71
27	1.70	2.05	2.47	2.77	3.69
28	1.70	2.05	2.47	2.76	3.67
29	1.70	2.05	2.46	2.76	3.66
30	1.70	2.04	2.46	2.75	3.65
40	1.68	2.02	2.42	2.70	3.55
60	1.67	2.00	2.39	2.66	3.46
120	1.66	1.98	2.36	2.62	3.37
∞	1.65	1.96	2.33	2.58	3.29

Reject H_0 if calculated value of t is **greater than** the critical value at the chosen significance level

$\alpha = .05$



v_2 \ v_1	1	2	3	4	5	6	7	8	9	10	12	15	20	25	30	40	60
1	161.5	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	246.0	248.0	249.3	250.1	251.1	252.2
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.46	19.46	19.47	19.48
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.63	8.62	8.59	8.57
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.52	4.50	4.46	4.43
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.83	3.81	3.77	3.74
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.40	3.38	3.34	3.30
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.11	3.08	3.04	3.01
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.89	2.86	2.83	2.79
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.73	2.70	2.66	2.62
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.60	2.57	2.53	2.49
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.50	2.47	2.43	2.38
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.41	2.38	2.34	2.30
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.34	2.31	2.27	2.22
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.28	2.25	2.20	2.16
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.23	2.19	2.15	2.11
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.18	2.15	2.10	2.06
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.14	2.11	2.06	2.02
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.07	2.04	1.99	1.95
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.02	1.98	1.94	1.89
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.00	1.96	1.91	1.86
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.97	1.94	1.89	1.84
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.94	1.90	1.85	1.80
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.92	1.88	1.84	1.79
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.89	1.85	1.81	1.75
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.88	1.84	1.79	1.74
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.78	1.74	1.69	1.64
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.69	1.65	1.59	1.53
120	3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.60	1.55	1.50	1.43
∞	3.84	3.00	2.61	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.51	1.46	1.39	1.32

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2014/2015 ACADEMIC YEAR FINAL EXAMINATIONS
GES 5625: ENVIRONMENTAL LAW

TIME: **Three hours**
INSTRUCTIONS: **Answer any FOUR questions**
All questions carry equal marks

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1. Section 2 of the Environmental Management Act, No. 12 of 2011 defines "environment" as "the natural or man-made surroundings at any place, comprising air, water, land, natural resources, animals, buildings and other constructions" whereas Section 1 (xi) of the National Environmental Management Act Number 107 of 1998 of South Africa defines "environment" as:

   > ... the surroundings within which humans exist and that are made of (i) the land, water and atmosphere of the earth (ii) micro-organisms, plant and animal life and (iii) any part or combination of (i) and (ii) and the interrelations among and between them; and the physical, chemical and aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing.

   In view of these two definitions:

   (a) Clearly outline what "law" and "environment" encompass. (6 marks)
   (b) What are the sources of environmental law? (5 marks)
   (c) What is the purpose of environmental law? (7 marks).
   (d) What are the most important considerations in defining international and national environmental law? (7 marks).
   (Total 25 marks)

2. The current Zambian Constitution (as amended by Act No. 18 of 1996) does not specifically state that citizens have the right to a clean and healthy environment. However, it pledges:

   > ...to ourselves that we shall ensure that the State shall respect the rights and dignity of the human family, uphold the laws of the State and conduct the affairs

of the State in such a manner as to preserve, develop and utilize its resources for this and future generations.

Discuss this constitutional provision in relation to Section 4 of the Environmental Management Act No. 12 of 2011 which provides for the right to a clean, safe and healthy environment, noting the importance of this right to the realization of sustainable development in Zambia. (25 marks)

3. (a) Explain the Principle of common but differentiated responsibilities. (10 marks)

(b) Explain, with the use of scientific and legal knowledge, how the Principle of common but differentiated responsibilities is expressed and applied in the following:

(i) UN Framework Convention on Climate Change (5 marks)
(ii) Kyoto Protocol (5 marks)
(iii) UN Convention on Biological Diversity. (5 marks)

(Total 25 marks)

4. The Post Newspaper of 29th June, 2015 carried a story entitled, 'KCM engages ZEMA, unions over 'poisonous' copper concentrates'. Part of the story reads as follows:

...Konkola Copper Mines (KCM) says it will not process the 5, 000 tonnes of copper concentrate imported from Chile until all parties are satisfied that there will be no adverse impact on the health of employees, communities and the environment.

Discuss the implications of this newspaper article in the light of scientific and (international and national) environmental legal knowledge that you have been exposed to. (25 marks)

5. "International law, scientific research and dissemination are the bedrock, or foundation of environmental law."

Discuss this statement with reference to any five (5) international conventions itemized below, clearly outlining their purpose and relevance to environmental wellbeing in Zambia:

(i) Basel Convention
(ii) Bamako Convention
(iii) Desertification Convention
(iv) CITES
(v) Ramsar Convention
(vi) UNFCCC and the Kyoto Protocol
(vii) World Heritage Convention
(viii) UNCLOS

(25 marks)

END OF EXAMINATION

The University of Zambia
School of Natural Sciences
Department of Mathematics and statistics

2014-15 Academic Year

MAT5041: Financial Mathematics

EXAM

Date : 17^{th} April, 2015

Attempt ALL questions. The marks are shown in brackets.
Time: Three hours.

Write clearly your computer number on the answer book.

Below is a list of formulas that might be helpful.

interest rates:

$$(1+i) = \left(1 + \frac{i^{(p)}}{p}\right)^p \quad , \quad (1-d) = \left(1 - \frac{d^{(p)}}{p}\right)^p$$

Annuities:

$$a_{\overline{n}|} = \frac{1-v^n}{i} \quad , \quad \bar{a}_{\overline{n}|} = \frac{i}{\delta} a_{\overline{n}|} \; , \; a^{(p)}_{\overline{n}|} = \frac{i}{i^{(p)}} a_{\overline{n}|}$$

Increasing/decreasing annuity functions :

$$(Ia)_{\overline{n}|} = \frac{\ddot{a}_{\overline{n}|} - nv^n}{i} \quad , \quad (Da)_{\overline{n}|} = \frac{n - a_{\overline{n}|}}{i}$$

Relation between forward and spot rates:

$$(1+f_{t,r})^r = \frac{(1+y_{t+r})^{t+r}}{(1+y_t)^t} = \frac{P_t}{P_{t+r}}$$

Price of a foward or a futures contract:

(i) For an asset with fixed income of present value I:

$$F = (S_0 - I)^{rT} \tag{1}$$

(ii) For an asset with dividends

$$F = S_0^{(r-q)T} \tag{2}$$

Loan Schedule Methods

(i) Progressive method:

$$L_t = X \sum_{j=1}^{n-t} v^j = X a_{\overline{n-t}|}$$

(ii) Retrogressive method

$$L_t = L_0(1+i)^t - X s_{\overline{t}|}$$

The price of fixed interest security allowing for income and capital gain tax:

$$P = D(1-t_1)a^{(p)}_{\overline{n}|} + Rv^n - t_2(R-P)v^n$$

(1) Write down simple (but exact) formulae expressing:

(i) v in terms of δ [1/2]

(ii) d in terms of δ [1/2]

(iii) i in terms of δ [1/2]

(iv) v in terms of i [1/2]

(v) d in terms of i [1/2]

(vi) i in terms of v [1/2]

(vii) δ in terms of i [1/2]

(viii) δ in terms of d [1/2]

[Total 4]

2 An investor wishes to find the present value of a stream of property income payments. She proposes to make the following assumptions.

* The level of current payments is K20,000 per annum, paid quarterly in advance.
* Payments will remain fixed for 5-year periods. At the end of each 5-year period the payments will rise in line with total inflationary growth over the previous five years.
* Inflation is assumed to be constant at 3% per annum.
* The interest rate for the calculation is 12% per annum effective.

Find the present value of the income stream assuming that the payments continue for 50 years. [Total 6]

(3) (a) Explain why the effective annual rate of interest is roughly twice the flat rate of interest. [2]

(b) A man borrows 7,500 to buy a car. He repays the loan by 24 monthly installments in arrears. The flat rate of interest is 9% pa.

(i) What is his monthly payment? [1]

(ii) What is the Annual percentage rate of change or APR on this transaction? [4]

[Total 7]

(4) A 9-month forward contract is issued on 1 April 2001 on a stock with a price of K7 per share. Dividends of 50p per share are expected after 2 and 8 months.

(a) Assuming a risk-free effective rate of interest of 6% pa and no arbitrage, calculate the forward price. [4]

(b) Calculate the value of the forward contract to both parties on 1 May 2001 if the new price of the stock is K7.20 per share. [3]

[Total 7]

(5) (a) Assuming a rate of interest of 6% pa, find the present value as at 1 January 2004 of the following annuities, each with a term of 25 years:

(i) an annuity payable annually in advance from 1 January 2005, initially of K3,000 pa, and increasing by K500 pa on each subsequent 1 January

(ii) an annuity as in (i), but only 10 increases are to be made, the annuity then remaining level for the remainder of the term

[6]

(b) An investor is to receive a special annual annuity for a term of 10 years in which payments are increased by 5% compound each year to allow for inflation. The first payment is to be K1,000 on 1 November 2005. Find the accumulated value of the annuity payments as at 31 October 2022 if the investor achieves an effective rate of return of 4% per half year. [4]

[Total 10]

(6) The force of interest, $\delta(t)$, is a function of time and at any time t (measured in years)) is given by

$$\delta(t) = \begin{cases} 0.07 - 0.005t \text{ , for , } t \leq 8 \\ 0.06 \text{ , for , } t > 8 \end{cases}$$

(a) calculate the accumulation at time $t = 10$ of K500 invested at time $t = 0$ [5]

(b) Calculate the present value at time $t = 0$ of a continuous payment stream at a rate of K$200e^{0.1t}$ paid from $t = 10$ to $t = 18$ [8]

[Total 13]

(7) (a) Give the definition of *futures* contract. Why it may be useful for market participants to buy/sell futures. [3]

(b) A landlord bought a property for K100,000 and let it for two years at the rent K5000 per year, paid at the end of each year. In two years the property has been sold for K120,000. Calculate the yield from the transaction assuming the landlord is free of tax. [6]

(c) Using the yield calculated in (b), estimate the duration of the sequence of payments 0; K5,000; K125,000. [6]

[Total 15]

(8) (a) A stock of nominal amount K200,000 is redeemable in 4 equal annual installments, the first being in 11 years time. Redemption is at par and interest of $7\frac{1}{2}\%$ pa is payable half yearly in arrears. All investors require a net yield of 9% pa.

(i) Calculate the price P_1 for the whole loan payable by an investor who is not subject to tax. [3]

(ii) Calculate the price P_2 for an investor who pays capital gains tax at 30% (payable as soon as it becomes due) but is not subject to income tax. [2]

(iii) Calculate the revised price P_3 for an investor who pays capital gains tax at 30% but is not subject to income tax, if the first interest payment is due in 4 months time and the first redemption payment is due in 10 years 10 months time. [2]

(iv) Calculate the revised price P_4 for an investor not subject to tax if the final installment is redeemable at a price of 120. [2]

(v) Calculate the revised price P_5 for an investor not subject to tax if interest payments are made at a rate of 9% pa for the first 3 years (and $7\frac{1}{2}\%$ pa thereafter). [2]

(b) On 1 January 2000 an investor purchased K10,000 nominal of a stock that pays coupons on 30 June and 31 December at the rate of 6% pa and is redeemable at par on 31 December 2012. The investor, who has no unused tax allowances, is liable for income tax payable at the rate of 40% on each 1 August in respect of coupons received during the previous calendar year. If the investors net redemption yield on this investment is 5% pa effective, calculate the price paid for the holding. [5]

[Total 16]

(9) A loan is repayable over 20 years by level installments of K1000 per annum made annually in arrear. Interest is charged at a rate of 5% per annum effective for the first 10 years, increasing to 7% per annum effect for the remaining term.

(a) Show that the amount of the original loan is K12, 033.56 (Minor discrepancies due to rounding will not be penalized). [4]

(b) The following are the details of the loan schedule for year x, i.e., the year running from exact duration $x-1$ years to exact duration x

	Loan outstanding at the beginning of the year	end of year Interest	end of the year Capital
year x	K8790.48	K439.52	K560.48

Determine the value of x [5]

(iii) At the beginning of the year 11, it is agreed that the increase in the rate of interest is will not take place, so that the rate remains at 5% per annum effect for the remainder of the loan. The annual installments will continue to be payable at the same level so that there may be a reduced term and a reduced final installment.

(i) Calculate by how many years, if any, the repayment schedule is shortened.

(ii) Calculate the amount of the reduced final installment.

(iii) Calculate the reduction in the total interest paid during the existence of the loan as a result of the interest rate not increasing.

[13]

[Total 22]

THE UNIVERISTY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2014/15 ACADEMIC YEAR FINAL EXAMINATION

MAT 5642: STATISTICS IN EPIDEMIOLOGY

TIME: THREE (3) HOURS

INSTRUCTIONS:

1. Answer ANY five (5) questions
2. Show all your work to earn full credit.
3. All questions carry equal marks.
4. You may use calculators and tables where provided.

Question 1

The 2013-14 Zambia Demographic and Health Survey (ZDHS) reports that a nationally representative sample of 16,411 women aged 15-49 in all selected households and 14,773 men aged 15-59 in all selected households were interviewed. Educational attainment is one of the characteristics that was ascertained and below is a table showing the results in percentages. In a 2×2 table, let:

1. cell 1,1 be number/percentage of men with level i of educational attainment.
2. cell 1, 2 be the number/percentage of men with no education
3. cell 2,1 be the number/percentage of women with level i of educational attainment.
4. cell 2, 2 be the number/percentage of women with no education
5. $i = \begin{cases} 1 \text{ if primary} \\ 2 \text{ if secondary} \\ 3 \text{ if more than secondary} \end{cases}$

i	Percentage		Level of attainment
3	5	8	More than secondary
2	40	49	Secondary
1	47	40	Primary
	8	3	No education
	100	100	
	Women	Men	

(a) (i) Obtain the odds ratios for i = 1, 2, and 3. Note that for each i you have a 2×2 table.

(ii) What is the trend in educational attainment when women are compared to men, i.e. are odds in favour of one gender or not?

(b) Collapse the data into a 2×2 table where the first column represents those without education and the second column those with some level of education. Let row 1 represent women and row 2 represent men. Using a significance level of 5% determine if there is a significant difference between the risk of illiteracy between men and women using Mantel-Haenszel statistic.

(c) Based on your analysis in (a) and (b), what policy direction would you suggest to the Government in one sentence.

Question 2

A study is planned to compare malnutrition in children in two socio-economic groups. One socio group, A, relies on traditional foods and the other, B, relies on commercially produced foods because households are in formal employment. Let P_1 be the prevalence of malnutrition in group A and P_2 be the prevalence of malnutrition in group B. The study is designed to test the hypotheses below:

H_0: $P_1 = P_2$ versus H_1: $P_1 > P_2$, at the significance level α and with power equal to $1 - \beta$.

(a) Assuming equal sample sizes in each group and normal theory, derive the formula for the appropriate sample size and show that it reduces to the one below.

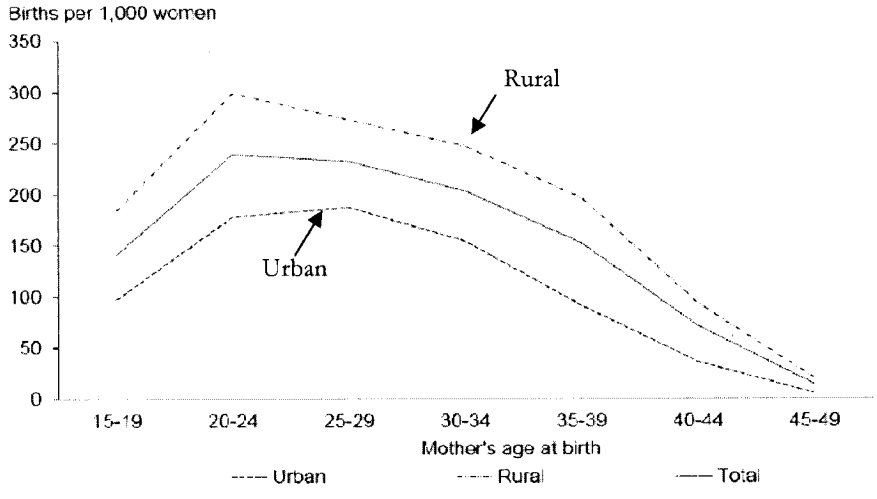
$$n = \frac{[Z_{1-\alpha}\times\sqrt{2pq}+Z_{1-\beta}\times\sqrt{p_1(1-p_1)+p_0(1-p_0)}]^2}{(p_1-p_0)^2}$$, where $p=\frac{P_1+P_2}{2}$ and $Z_{1-\alpha}$ and $Z_{1-\beta}$ are standard normal values.

(b) If previous studies seem to indicate that $P_1 = 0.4$ and $P_2 = 0.3$ what sample size is ideal for the study if $\alpha=0.05$ and $\beta = 0.20$.

Question 3

Population size is an important aspect of national development. To government, population size poses its own challenges, such as food security, health provision, employment etc. The 2013-14 Zambia Demographic and Health Survey (ZDHS) has information on various characteristics of the population in Zambia, including fertility which gives rise to population size. Monitoring fertility of a nation is important. Below is a graph and table copied directly from the 2013-14 ZDHS report on fertility. Examine the graph and table from the report and answer the questions that follow.

Figure 1 **Age specific fertility rates**



Fertility is gradually declining in Zambia. Figure 2 shows the decrease in the TFR from 6.5 births per woman as estimated in the 1992 ZDHS to 5.3 births per woman in the 2013-14 ZDHS.

Table 4 Fertility preferences by number of living children

Percent distribution of currently married women age 15-49 by desire for children, according to number of living children, Zambia, 2013-14

Desire for children	Number of living children[1]							Total
	0	1	2	3	4	5	6+	
Have another soon[2]	82.3	25.2	17.9	12.4	9.0	6.4	2.6	13.8
Have another later[3]	2.2	63.2	60.9	53.4	40.6	32.3	12.7	41.0
Have another, undecided when	2.2	3.1	1.2	3.0	2.0	1.0	0.6	1.7
Undecided	1.5	2.0	3.3	5.1	6.5	6.8	5.4	4.7
Want no more	2.5	4.4	14.3	23.2	39.6	49.3	72.7	35.0
Sterilised[4]	0.0	0.2	0.9	1.6	2.0	2.7	3.8	1.9
Declare infecund	8.3	1.6	1.3	1.2	0.3	0.8	2.1	1.5
Missing	1.0	0.3	0.3	0.2	0.1	0.6	0.2	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number of women	290	1,345	1,734	1,654	1,453	1,184	2,198	9,859

[1] The number of living children includes current pregnancy
[2] Wants next birth within 2 years
[3] Wants to delay next birth for 2 or more years
[4] Includes both female and male sterilisation

(a) Provide a brief summary of the comparison of the fertility rates between rural and urban women based on the graph. Please, present your summary in bullet form.

(b) Collapse Table 4 above into a 2×2 table as indicated below.

		Number of living children		
		0	1+	Total
Have desire for children	Yes			
	No			
	Total			

Please Note: Those without desire for children include all categories other than the first three.

(c) (i) Obtain the odds of having no child for those with desire to have children.
(ii) Obtain the odds of having no child for those with no desire to have children.
(iii) Obtain the odds ratio and interpret.

Question 4

The Case-control study design has its benefits and drawbacks. However, the Bayes theorem allows one to deal with some of the drawbacks in that it allows one to change direction of prediction. Let events and quantities be defined as below:

1. D+ =an individual has disease or condition and D- indicate the individual is negative
2. E+ =an individual is exposed to an agent and E- indicate the individual is not exposed.
3. ψ be the exposure odds ratio
4. $\text{CIR} = \frac{\Pr(D+|E+)}{\Pr(D+|E-)}$

(a) (i) Write down an expression for ψ in terms of 1 and 2.
(ii) State the reason why CIR is a difficult measure to attain in a case-control.

(b) It can be shown that : $\text{CIR} = \psi \times \left[\frac{\Pr(D+|E+)}{\Pr(D+|E-)}\right] \times \left[\frac{1-\Pr(E+)}{\Pr(E+)}\right]$

(i) Show that the CIR can be expressed as:

$$CIR = \psi \times \left[\frac{Pr(D+|E+)}{Pr(D+|E-)}\right] \times \left[\frac{Pr(E-|D+)Pr(D+)+Pr(E-|D-)Pr(D-)}{Pr(E+|D+)Pr(D+)+Pr(E+|D-)Pr(D-)}\right]$$

(ii) Using (i) obtain a simplified version for CIR assuming the disease or condition is rare.

(c) Suppose that the true population probabilities showing the distribution of disease and an exposure are as shown below:

		Disease status	
		D+	D-
Exposure status	E+	0.25	0.16
	E -	0.15	0.44

(i) Obtain a 2×2 table of the true case-control probabilities for the population.

(ii) Using (i) obtain the true value of ψ

(iii) Using (i) obtain the true value of CIR.

Question 5

(a) Define each of the following terms using a specific example:

(i) Target population

(ii) Study population

(iii) Random error

(iv) Systematic error

(b) Suppose that in a certain community a proportion of members lost their jobs due to a major employer who closed down due to a depressed economy. Assume that the prevalence of depression by loss of job is as shown in the table below.

		Depressed?	
		Yes	No
Lost a job?	Yes	10	200
	No	15	1000

Assume that after some time has elapsed, a survey is carried out in the community and its design is such that depressed individuals will be treated as cases and those who are married and not depressed will be used as controls. Assume that at the time of the survey the prevalence of each of the three factors were as follows:

1. 5% are depressed
2. 20% lost a job and
3. 60% are married.

(i) Construct a 2×2 table of how the results of the survey will capture the data.

(ii) Calculate the odds ratio based on the data in (i).

(iii) Calculate the odds ratio based on the data prior to the survey.

(iv) Calculate the relative bias from the survey results and its direction.

Question 6

(a) (i) State the strengths of a cohort study

(ii) State the weaknesses of a cohort study.

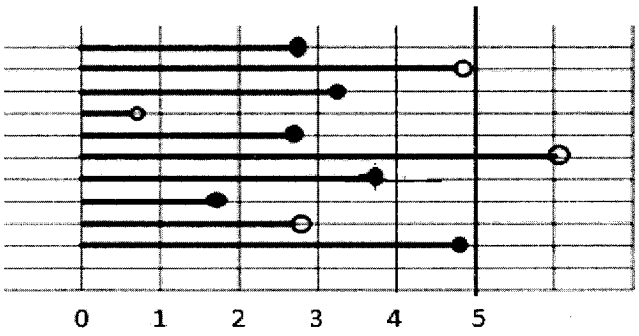
(b) (i) State the actuarial estimator of the cumulative incidence.

(ii) How does this estimator differ from the ordinary estimator of cumulative incidence?

(c) 10 youths were enrolled into a five-year program for youth empowerment. Their progress is pictorially shown below. A solid circle indicates the youth dropped out of the program and an open circle indicates censored data.

(i) Obtain an actuarial estimate of risk of dropping out by one - year intervals.

(ii) Calculate the three-year risk of dropping out.



END OF EXAMINATION

The University of Zambia

School of Natural Sciences

Department of Mathematics and Statistics

2014/15 Academic Year

MAT 5652 : Econometrics

Maximum Time Allowed: **Three (3)** hours

Instructions: (i) Answer any four questions

(ii) Show all necessary work

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1. a (i) Consider a linear trend equation $Y = \alpha + \beta T + U$. Y is observed annually from 2010 to 2014 (5 time points). Assign integer values from -2 to 2 to regressor T. Show that

$\widehat{\beta} = \frac{\sum(Y_i - \bar{Y})(T_i - \overline{T})}{\sum(T_i - \overline{T})^2}$ reduces to $\hat{\beta} = \frac{\sum Y_i T_i}{\sum T_i^2}$

(ii) The number of mobile subsribers in Zambia from 2010 to 2014 are given in the following table:

Year	2010	2011	2012	2013	2014
Subsribers in thousands	38.1	80.0	170.4	354.5	744.4

Estimate the annual growth rate of subsribers by fitting a constant growth curve.

b. Consider a first order autoregressive scheme

$Y_t = \alpha + \beta Y_{t-1} + U_t$ where U_t are independently and identically distributed random variables with $E(U_t) = 0 \; and \; V(U_t) = \sigma^2$. Assuming that the scheme started a long time ago, hence it can be re-written as

$Y_t = \alpha(1 + \beta + \beta^2 + \cdots) + (U_t + \beta U_{t-1} + \beta^2 U_{t-2+\cdots})$

(i) Find $E(Y_t)$ and state condition under which $E(Y_t)$ exist.

(ii) Find V(Y_t).

(iii) Find autucovariances of order one and two.

(iv) Find autocovarince function of the scheme using your answer of part (iii). Give reasons why the scheme is covariance stationary.

(v) State the reason why autoregressive scheme

$Y_t = 0.05 + 0.95Y_{t-1} + U_t$ is covariance stationary.

c. Find the transformation that will linearize the function

$$Y = \frac{e^{\alpha+\beta X}}{1+e^{\alpha+\beta X}}$$

2. a. Let X_2, X_3, X_4 be possible regressors for a response variable Y. Label Y as 1 and $X_i as \; i, i = 2,3,4$. Explain which of the following are true or not true:

(i) $R^2{}_{1.23} = 0.87 \; and \; R^2{}_{1.234} = 0.82$

(ii) For any regressor X

$$(\sum(X-\bar{X})^2)(\sum(Y-\bar{Y})^2) - (\sum(X-\bar{X})(Y-\bar{Y}))^2 = -75$$

(iii) $R^2{}_{1.23} = r^2{}_{12} + r^2{}_{13.2}(1-r^2{}_{12})$

b. A production function Q is regressed on labour L and capital C as $log\ Q = \alpha + \beta_L log\ L + \beta_C\ log\ C + U$. The following estimates were obtained using 40 observations:

$\widehat{\beta_L} = 0.7,\ s.e(\widehat{\beta_L}) = 0.102\ ;\ \widehat{\beta_C} = 0.2,\ s.e(\widehat{\beta_c}) = 0.102$

Find 95% confidence intervals for each of $\beta_L\ and\ \beta_C$ and use these confidence intervals to test separately the hypotheses $\beta_L = 1\ and\ \beta_C = 0$ at the 5% significance level.

c. Consider the linear regression model Y=Xβ + U with (K-1) regressors. Assume U_{nx1} is a vector of iid random variables with $E(U_i) = 0\ and\ V(U_i) = \sigma^2$; where U_i is the ith component of U.

(i) Let C be an arbitrary K-element vector of known constants and **a** be an arbitrary n-element vector of constants. Find the condition on **a** and C such that $\boldsymbol{a}'Y\ is\ an\ unbiased\ estimator\ of\ C'\beta$.

(ii) Find $V(\boldsymbol{a}'Y)$.

(iii) Find vector **a** which minimizes $\boldsymbol{a}'\boldsymbol{a}\ subject\ to\ X'\boldsymbol{a} = C$.

3. a (i) Consider a k dimensional random vector X whose distribution is $N(0, \sigma^2 I)$. Find the distribution of $X'(\sigma^2 I)^{-1}X$.

(ii) Let $X_{kx1} \sim N(0, \sum)$, where $\sum$ is a positive definite matrix. Find the distribution of $X' \sum^{-1} X$.

b. Consider the linear regression equation

$Y = X\beta + U \; where \; U_{nx1} \sim N(0, \sigma^2 I) \; and \; \beta \; is \; a \; kx1 \; column.$

Let $b = (X'X)^{-1}X'Y$ be the least square estimator of β and e be the vector of residuals

(i) Show that e = MY where $M = I - X(X'X)^{-1}X'$

(ii) Show that e = MU

(iii) Find the rank of M given that M is symmetric idempotent matrix

(iv) Show that $e'e = U'MU$

(v) Show that $E(e'e) = \sigma^2(n-k)$

c. Given the linear regression equation stated in part b,

(i) Find cov(b)

(ii) Determine the distribution of Y

(iii) Determine the distribution of b

(iv) Determine the distribution of

$(Rb - R\beta)'[\sigma^2 R(X'X)^{-1}R']^{-1}(Rb - R\beta)$

where R is a q x k matrix of known constants, q<k.

4. a. Consider a multiple regression model with k-1 regressors for which all classical assumptions hold. We wish to test the hypothesis that there is no relationship between Y and X i.e

$H_o: \beta_2 = \beta_3 = \cdots = \beta_k = 0$ against the alternative that at least one

of the β's is non zero.

(i) Drive the appropriate test statistic

(ii) State the distribution of the test statistic in (i) and associated number of degrees of freedom.

b. Consider the linear model $Y = X\beta + U$ *where* β *is a* $kx1$ vector of parameters. Assume $U_{nx1} \sim N(0, \sigma^2 I)$. Partition the data set of n sample observations into $n_1 and\ n_2$ observations, where n_1 observations are to be used for estimation and n_2 observations to be used for prediction.

Using usual nomenclature,

define $d = Y_{(2)} - X_{(2)} b_{(1)}$ *where* $b_{(1)}$ is the least square estimator of β. Find E(d) and cov(d).

c. Per capita consumption of food (q) in Zambia was estimated by the regression equation $logq = \alpha + \beta_1 logp + \beta_2 logY + U$, using the annual averages of *q , p and Y* for periods 1977- 1991 and 1998 – 2012 , where *p* is the price of the food and *Y* is the per capita income . Many state owned companies in Zambia were privatized after 1991 . Apply Chow test at 5% significance level to comment if the regression coefficients estimated from period before privatization remained stable after privatization using the following statistics:

Period	n	RSS

1977-1991	15	0.1151
1998-2012	15	0.0544
all observations combined	30	0.2866

5. a A random sample of n observations $X_1, X_2, \ldots, X_n$ is generated from a population with mean μ and variance σ^2. Let

$$Z = \frac{1}{2}X_1 + \frac{1}{4}X_2 + \frac{1}{8}X_3 + \cdots + \frac{1}{2^{n-1}}X_{n-1} + \frac{1}{2^n}X_n$$

(i) Find E(Z).

(ii) Determine if Z is a consistent estimator of μ. You might use the following: $a + ar + ar^2 + \cdots + ar^{n-1} = \frac{a(1-r^n)}{1-r}$.

b. Given the linear regression model

$$Y = X\beta + U \text{ with } U_{nx1} \sim N(0, \sigma^2 I)$$

(i) Write the pdf of U

(ii) Write the pdf of Y

(iii) Find the maximum likelihood estimator of vector θ where

$$\theta = \begin{pmatrix} \beta \\ \sigma^2 \end{pmatrix}.$$

c. Let $\hat{\theta}$ be the maximum likelihood estimator of θ stated in part (b), find the information matrix $I(\theta)$.

UNIVERSITY OF ZAMBIA

DEPARTMENT OF MATHEMATICS AND STATISTICS

MAT5662 - THEORY OF NON-PARAMETRIC STATISTICS

2014/2015 ACADEMIC YEAR EXAMINATIONS

TIME ALLOWED: 3 HOURS DATE: July, 2015

INSTRUCTIONS
There are FIVE (5) questions in this paper.
Attempt any FOUR (4) questions.
Full credit will only be given where all the necessary work is shown.

1. (a) Define the following:
   (i) Equal in distribution.
   (ii) Distribution-free statistics.
   (iii) Non-parametric distribution-free statistics.

   (b) Prove the following:
   (i) A random variable X has a distribution that is symmetric about β if and only if $X-\beta$ and $\beta-X$ are equal in distribution.
   (ii) If $W=X_{(n)}-X_{(1)}$ with $X_1, X_2, \ldots, X_n$ a random sample from a continuous distribution with *cdf* $P(x)$ then
   $E(W)=\int_{-\infty}^{\infty}(1-(P(x))^n-(1-P(x))^n)\,dx$.

   (c)
   (i) Derive the general expression for the variance of a $U-$statistics for an estimable parameter γ.
   (ii) Using the result in (i) above find the variance of the $U-$statistic for the population mean.

2. (a) Define the following:
   (i) Estimable parameter.
   (ii) $U-$statistics for estimable parameter.
   (iii) Convergence in probability.

   (b) Prove the following:
   (i) If $X_1, X_2, \ldots, X_n$ is a random sample of size n from a continuous distribution with *cdf* $P(x)$ and $Z=\frac{1}{2}\left(X_{(n)}-X_{(1)}\right)$ then
   $F_Z(z)=n\int_{-\infty}^{z}(P(2z+x)-P(x))^{n-1}p(x)dx$ where $p(x)$ is *pdf*.
   (ii) If Z is a continuous random variable with distribution that is symmetric about zero, then the random variables $\mid Z \mid$ and $\psi(Z)$ are stochastically independent where

$$\psi(l)=\begin{cases}1 & \text{if } t>0\\ 0 & \text{if } t\leq 0\end{cases}$$

(c) Given a random sample of size n from a continuous distribution with *pdf* $p(x)$ and *cdf* $P(x)$. Derive the following:

(i) Joint *pdf* for the r^{th} and s^{th} order - statistics with $r < s$.

(ii) Conditional *pdf* of s^{th} order - statistics given the r^{th} order - statistics with $r < s$.

3. (a) Define the following:

(i) Absolute rank.

(ii) Signed rank statistics.

(iii) Limiting distribution.

(b) Prove the following:

(i) If $U(X_1, X_2, \ldots, X_n)$ is a $U-$statistics with symmetric kernel $h(X_1, X_2, \ldots, X_k)$ then
$\lim_{n\to\infty} n\ var(U(X_1, X_2, \ldots, X_n)) = K^2\xi_1$.

(ii) If $X_1, X_2, \ldots, X_n$ is a random sample from a continuous distribution and $R = (R_1, R_2, \ldots, R_n)$ is a rank vector, where R_i is the rank of X_i, $\mathfrak{B} = \{r : r$ is a permutaion of integers, $1, 2, \ldots, n\}$ then R is uniformly distributed over $\mathfrak{B}$.

(c)

(i) State Slutsky's theorem.

(ii) Show that the one-sample $t-$test statistics for testing $H_0 : \mu = \mu_0$ is asymptotically standard normal when H_0 is true.

4. (a) Define the following:

(i) Consistent estimator.

(ii) Convergence in quadratic mean.

(iii) Projection of W onto a space ν.

(b) Prove the following:

(i) If $X_1, X_2, \ldots, X_n$ is a random sample from a population, γ is an estimable parameter of degree k and $U(X_1, X_2, \ldots, X_n$ is a $U-$statistics for γ, then $\sqrt{n}U(X_1, X_2, \ldots, X_n) - \gamma)$ has a limiting normal distribution with mean zero and variance $K^2\xi_1$.

(ii) If $Z_1, Z_2, \ldots, Z_n$ is a random sample from a continuous distribution that is symmetric about zero and Q is the number of positive $Z_{i'}s$ for $Q = q$, define $S_1 < S_2 < \ldots < S_q$ to be ordered absolute ranks of $Z_{i'}s$ that are positive, then $P(Q = q, S_1 = s_1, S_2 = s_2, \ldots, S_q = s_q) = (\frac{1}{2})^n$.

(c) Let $X_1, X_2, \ldots, X_n$ be a random sample from a distribution with *pdf* $p(x) = \theta k^{-\theta} x^{\theta-1}$, $0 < x < k$, $k > 0$, $\theta > 0$, find the following:

(i) *pdf* for $X_{(r)}$.

(ii) Joint *pdf* for $X_{(r)}$ and $X_{(s)}$ where $r < s$.

5. (a)

(i) Show that $\sum_{i=r}^{n} \binom{n}{i}(P(x))^i(1-P(x))^{n-i} = I_{P(x)}(r,\ n-r+1)$ where $P(x)$ is *cdf* and $I_{P(x)}(r,\ n-r+1)$ is incomplete beta function.

(ii) From the result given in (i) above derive the *pdf* of the r^{th} order statistics.

(b) Prove the following:

(i) If $X_1, X_2, \ldots, X_m$ and $Y_1, Y_2, \ldots, Y_n$ are independent random samples from $F(x)$ and $F(y-c)$ respectively, $R = (Q_1, Q_2, \ldots, Q_m, R_1, R_2, \ldots R_n)$ as the rank vector for the combined samples, then when $H_0 : \ c = 0$ is true $W = \sum_{i=1}^{n} R_i$ is symmetric about $\frac{1}{2}n(m+n+1)$.

(ii) If $W(X_1, X_2, \ldots, X_n)$ treats the n *iid* random variables $X_1, X_2, \ldots, X_n$ symmetrically and $E(W) = 0$, V^* a projection of W onto space ν, then for any $V \in \nu$
$E\{(W-V^*)^2\} \leq E\{(W-V)^2\}$

(c) Let $X_1, X_2, \ldots, X_n$ be a random sample from a continuous distribution that is symmetric about unknown median θ, and has *cdf* $F(.)$, let W^+ be the Wilcoxon signed rank statistics for testing $H_0 : \theta = \theta_0$ *vs* $H_a : \theta < \theta_0$.

(i) Write the distribution of W^+ under H_0.

(ii) Evaluate the distribution of W^+ under H_0 for $n = 3$.

End of examination.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS

2014 ACADEMIC YEAR
FIRST SEMESTER EXAMINATIONS

MAT5671 : PROBABILITY AND MATHEMATICAL STATISTICS

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: 1. Answer All Questions
2. Show All Essential Working

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1. (a) Let A and B denote independent events.
   (i) Show that A and B^c are also independent events.
   (ii) If $P(A) = 0.2$ and $P(B) = 0.1$, find $P(A \cup B^c)$.

   (b) Let X be a random variable with moment generating function $M_X(t)$ and cumulant generating function $C_X(t)$, and let $Y = aX + b$, where a and b are constants. Let Y have moment generating function $M_Y(t)$ and cumulant generating function $C_Y(t)$.
   (i) Show that $C_Y(t) = bt + C_X(at)$.
   (ii) Find the coefficient of skewness of Y in the case that $M_X(t) = (1-t)^{-2}$ and $Y = 3X + 2$ (you may use the fact that $C_Y'''(0) = E(Y - \mu_Y)^3$).

   (c) Consider two random variables X and Y with joint probability density function (pdf)
   $$f(x,y) = k(1-xy) \quad , \quad 0 < x < 1 \ , \ 0 < y < 1$$
   (i) Show that $k = \frac{4}{3}$.
   (ii) Find the marginal pdf of X and Y.
   (iii) Find the conditional pdf of Y given $X = \frac{1}{2}$.
   (iv) Determine the conditional expectation $E\left(Y|X = \frac{1}{2}\right)$.

2. (a) A bag contains 8 black and 6 white balls. Two balls are drawn out at random, one after the other and without replacement. Calculate the probabilities that:
   (i) The second ball drawn out is black.
   (ii) The first ball drawn out was white, given that the second ball drawn out is black.
   (iii) The balls are of the same colour.

   (b) A random sample of size 10 is taken from a normal distribution with mean $\mu = 20$ and variance $\sigma^2 = 1$. Find the probability that the
   (i) sample mean is less than 19.5, that is $P(\bar{X} < 19.5)$
   (ii) sample variance exceeds 1, that is $P(S^2 > 1)$.

(c) Data collected on claim amounts (in Kwacha) for two postcode regions give the following values for n (the number of claims), $\bar{x}$ (the mean claim amount) and s (the sample standard deviation) of the claim amounts.

	Region 1	*Region 2*
n	25	18
$\bar{x}$	120.2	142.7
s	58.1	62.2

(i) Test whether the mean claim amounts for the two regions are different.
(ii) State the assumptions required for the test in (i) to be valid.

3. (a) In a large portfolio 65% of the policies have been in force for more than five years. An investigation considers a random sample of 500 policies from the portfolio. Calculate an approximate value for the probability that
(i) fewer than 300 of the policies in the sample have been in force for more than five years.
(ii) the number of policies that have been in force for more than five years is 315 or more but less than 350.

(b) Consider the discrete random variable X with probability function

$$f(x) = \frac{4}{5^{x+1}} \quad , \quad x = 0, 1, 2, \ldots$$

(i) Show that the moment generating function of the distribution of X is given by $M_X(t) = 4(5 - e^t)^{-1} \quad , \quad e^t < 5$
(ii) Determine $E[X]$ using the moment generating function given in part (i).
(iii) Hence or otherwise find $Var(X)$.

(c) Respondents with investments were asked to specify their satisfaction with the current return received from their full portfolio of investment. This was in the form of a four-point qualitative scale: very satisfied, quite satisfied, a little disappointed, very disappointed. The following two-way table of frequencies was obtained.

	percentage in type of trust			
	<10	*10 - 25*	*25- 50*	*>50*
very satisfied	1	6	7	6
quite satisfied	8	29	36	27
a little disappointed	10	37	28	15
very disappointed	3	4	2	1

In order to investigate whether there is any relationship between the percentage in such trusts and satisfaction with current return, a chi-square test is to be performed.

(i) Calculate the expected frequencies for the above table under an appropriate hypothesis (which should be stated) and comment on why it would be inappropriate to carry out a chi-square test directly with these data.

(ii) Combining the very satisfied and quite satisfied categories together and the a little disappointed and very disappointed categories together results in the following reduced two-way table.

	percentage in type of trust			
	<10	*10 - 25*	*25 - 50*	*>50*
satisfied	9	35	43	33
disappointed	13	41	30	16

Perform the required chi-square test at the 5% level using this reduced table and comment on your conclusion.

4. (a) (i) Show that for continuous random variables X and Y: $E[Y] = E[E(Y|X)]$.

(ii) Suppose that a random variable X has a standard normal distribution, and the conditional distribution of a Poisson random variable Y, given the value of $X = x$, has expectation $g(x) = x^2 + 1$. Determine $E[Y]$.

(b) In a random sample of 200 policies from a company's private motor business, there are 68 female policyholders and 132 male policyholders. Let the proportion of policyholders who are female in the corresponding population of all policyholders be denoted p. Test the hypothesis

$H_0: p = 0.4$ against $H_1: p < 0.4$

stating clearly the approximate probability value of the observed statistic and your conclusion.

(c) Let X be a geometric random variable with probability function

$P(X = x) = p(1-p)^{x-1}$, $x = 1,2, \ldots$

(i) Find an expression for $P(X > 2)$.
(ii) Derive the probability generating function (PGF) for X.
(iii) Use the PGF to derive the mean and variance of X.

5. (a) Consider three random variables X, Y, and Z with the same variance $\sigma^2 = 4$. Suppose that X is independent of both Y and Z, but Y and Z are correlated, with correlation coefficient $\rho_{YZ} = 0.5$.

(i) Calculate the covariance between X and U, where $U = Y+Z$.
(ii) Calculate the covariance between Z and V, where $V = 3X - 2Y$.
(iii) Calculate the variance of W, where $W = 3X - 2Y + Z$.

(b) The number of claims, X, which arise in a year on each policy of a particular class is to be modelled as a Poisson random variable with mean λ. Let $X_1, X_2, \ldots, X_n$ be a random sample from the distribution of X.

(i) Use moment generating functions to find the distribution of $Y = \sum_{i=1}^{n} X_i$.
(ii) Determine whether or not the variable $V = 2X + 5$ has a Poisson distribution.
(iii) State the approximate distribution of $\bar{X}$ in the case that n is large.

An actuary is interested in the level of claims being experienced and wants in particular to test the hypothesis $H_0: \lambda = 1$ against $H_1: \lambda > 1$. She decides to use a random sample of size $n = 100$ and the best (most powerful) available test. You may assume that this test rejects H_0 for $\bar{x} > k$, for some constant k.

(iv) Show that the value of k for the test with level of significance 0.01 is $k = 1.2326$.

(v) Calculate the power of the test in part (iv) in the case $\lambda = 1.2$.

END OF EXAMINATION