THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

POST GRADUATE TABLE OF CONTENTS

21. MAT 5331 - Functional analysis

22. MAT 5611 - Statistical inference

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5145: ECOLOGY AND MANAGEMENT OF WILDLIFE POPULATIONS
PRACTICAL PAPER

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

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1. Delta Farms Ltd is considering establishing a nature reserve in the Serenje District along the Lulimara River. Initial investigations show that the range is suitable for Impala, Zebra, Wildebeest, Kudu and Buffalo. Nine per cent (9 %) of the range is a steep hill and in addition only 60% of the range is within 6.5 km from water. The soils are generally suitable for a protected area. Furthermore, results from your preliminary estimates indicate that the production of key forage species averages about 5000kg/ha of dry matter per year. The proposed reserve is 10,000 ha in size. Assuming that allowable use is 55% of the total biomass, and that the daily dry matter intake is 2% of the animal body weight,

   (a) Determine the number of 950 kg buffaloes you would stock as your base herd in the area.
   (b) Determine Animal Units / ha/month of the buffalo.
   (c) Determine number of hectares you would need to stock 160 of 95kg wildebeest per year in this reserve.
   (d) Discuss limitations of this method in estimating stocking rate of wildlife species.

2. Biologists monitoring populations of Impala (*Aeopyceros melampus,* Lichtenstein 1812) on Chete island in lake Kariba, Sinazongwe between 1958 and 1985 gave figures as given in the Table 1 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.

Table 2: 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	75	65	95

Using the information and data provided,
(a) Discuss the population trends of Impala on the island.
(b) Discuss factors most significant to the population growth of this species.

3. Two hundred (200) skulls of Kafue Lechwe (*Kobus leche kafuensis*) were collected and aged as follows:

Table 3: Aged skulls of Kafue Lechwe collected in 1975 in Kafue Flats Game Management Area.

Age class	Number of skulls
0.0	95
1.0	13
2.0	15
3.0	11
4.0	13
5.0	6
6.0	5
7.0	11
8.0	14
9.0	8
10.0	6
11.0+	3

a) Construct a life table of this population
b) Assuming that m_x for the species is known to be 0.5 for all age classes except for ages 0 and 1, determine R_o and r_m for the species population.
c) Discuss limitations and assumptions for determining r_m

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5145: ECOLOGY AND MANAGEMENT OF WILDLIFE POPULATIONS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS: ANSWER QUESTIONS **ONE** AND **TWO** AND ANY OTHER **THREE** QUESTIONS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

---

1. Using the Lotka-Volterra equations based on the logistic model,

   (a) Describe the interaction of two species which are competing for food or space and discuss the four outcomes of this interaction.

   (b) Describe the interaction by predation of Sp1 (prey) and Sp2 (predator) and discuss the functional and numerical responses of this relationship.

2. Lamont Cole (1954) noted that natural history of species population could be summarised by parameters l_x and m_x,
   (a) Discuss parameters l_x and m_x in population growth as applied to a single population model.
   (b) Describe methods used in deriving these parameters in a vertebrate species population.

3. In the regulation of species populations, discuss the views of Wynne-Edwards (1964) and discuss these in contrast with those expressed by:
   (a) Pimentel *et al* (1965).
   (b) Christian and Davis (1964).

4. (a) Compare and contrast the concepts of carrying capacity and stocking rate in the management of wildlife species.
   (b) Describe aerial census method.

5. (a)Describe the wildlife protected area system of Zambia.
   (b)Discuss harvesting strategies in wildlife management.

TURN OVER

6. Summarise each of the following:
   (a) $1 - e^{-H}$ in the exploitation of wildlife populations.
   (b) Quotas for harvesting wildlife species.
   (c) King Census method.
   (d) Restoration of *Damaliscus lunatus* habitat.

7. Summarise each of the following as used in wildlife population management studies
   (a) $N_t = N_o e^{rt}$
   (b) *Syncerus caffer*.
   (c) r- Selection strategies.
   (d) Wildlife species territory.

8. Discuss what you understand by the concept of Maximum Sustainable Yield (MSY) and give reasons why this concept is regarded as an epitaph in harvesting species populations.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
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2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5145: ECOLOGY AND MANAGEMENT OF WILDLIFE POPULATIONS
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THE UNIVERSITY OF ZAMBIA
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2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5145: ECOLOGY AND MANAGEMENT OF WILDLIFE POPULATIONS
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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR: FIRST SEMESTER
FINAL EXAMINATIONS

BIO 5155: AQUATIC ECOLOGY AND FISH POPULATIONS
THEORY PAPER I

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS: ANSWER QUESTION NUMBER **ONE** IN SECTION **A** AND QUESTION **FIVE** IN SECTION **B.** ANSWER **TWO** QUESTIONS FROM **EACH** SECTION AND A **FIFTH** QUESTION FROM **EITHER** SECTION. **ILLUSTRATE** YOUR ANSWERS AS APPROPRIATE.

SECTION A: Aquatic Ecology

1. Explain how vertical distributions of oxygen concentrations can, be used to assess the relative productivity of a lake in conditions of thermal stratification.

2. Summarise the following as used in the categorisation of aquatic ecosystems:
   (a) Annual minimum and maximum water temperatures.
   (b) Water currents.

3. (a) Discuss the types of ions that determine the alkalinity of freshwater bodies; and
   (b) Explain the relationship, as appropriate between alkalinity and productivity of inland aquatic ecosystems.

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

SECTION B: Fish Populations

5. Summarise the following in relation to management of fish stocks:
   (a) Age at first capture (t_c).
   (b) Total Allowable Catch (TAC).
   (c) Maximum Economic Yield (MEY).

TURN OVER

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

7. 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_{∞}).

8. (a) Explain the type of data required for estimating the Maximum Sustainable Yield (MSY) when applying the Surplus Production Models.
   (b) Compare and contrast the Schaefer and Fox Models, in estimating of Maximum sustainable Yields.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5165: ECOLOGY AND MANAGEMENT OF TROPICAL WETLANDS
PRACTICAL PAPER

TIME: THREE HOURS

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

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1. Study the maps provided in **Figures 1a** and **1b**. Using the wetland ecological character as defined by the Ramsar Convention, compare and contrast the Zambezi delta (Fig. 1 a) along the Indian Ocean and the Okavango internal delta (Fig. 1b) in the arid region of Southern Africa.

2. (a) Draw the general map of wetlands of Zambia.
   (b) Describe the procedure for identifying and delineating a wetland.

3. Describe each of the following techniques in assessing wetland condition:
   (a) Point- Intercept method.
   (b) Point -centered quarter method.
   (c) Quadrat method.

TURN OVER

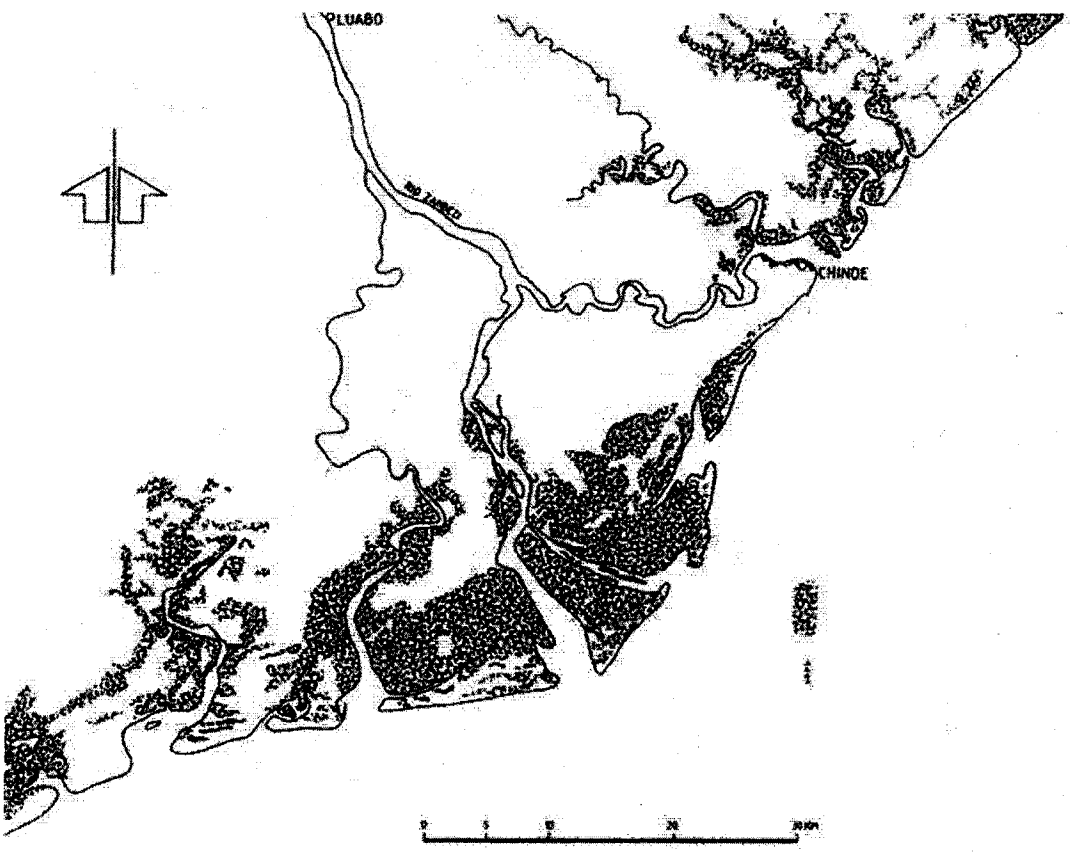

FIGURE 1a: Zambezi Delta

GO TO NEXT PAGE

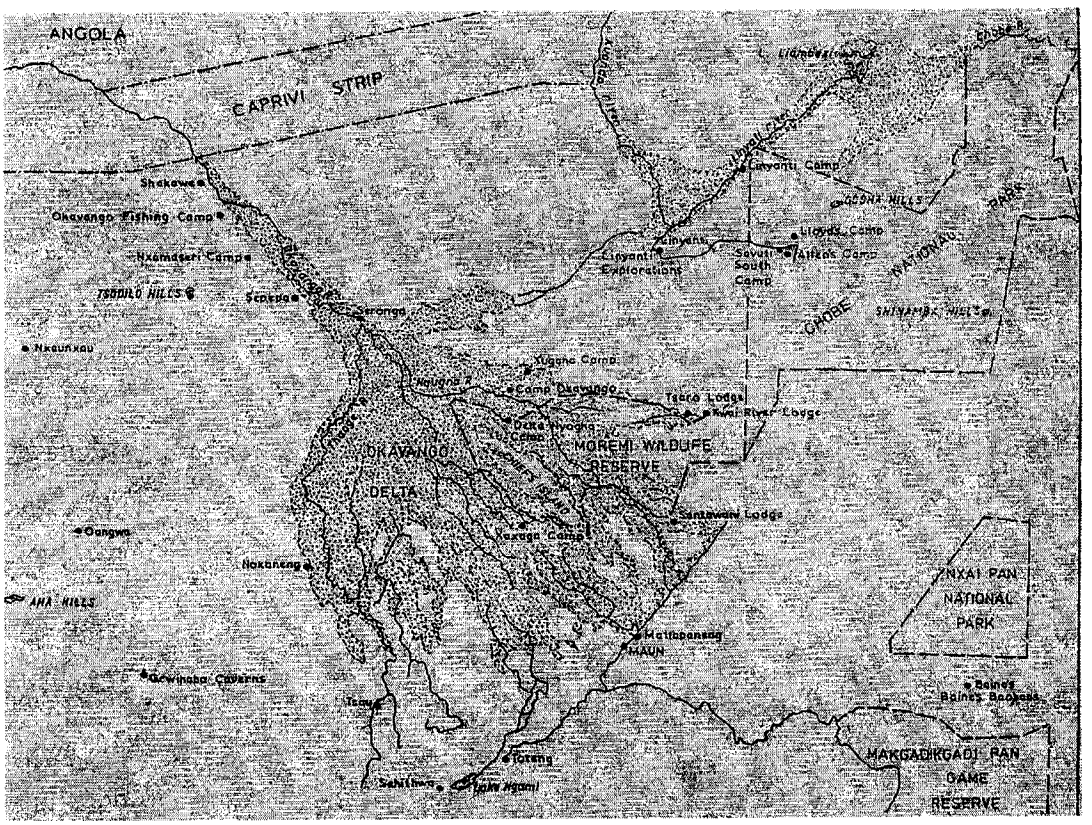

FIGURE 1b: Okavango Delta

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5165: ECOLOGY AND MANAGEMENT OF TROPICAL WETLANDS
THEORY PAPER

TIME: THREE HOURS

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

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1. Compare and contrast the main features of the Marine and Lacustrine wetland habitat systems.

2. Explain the concept of a *wise use* of wetlands and discuss its limitations in governance of a flood plain wetland system in Zambia.

3. (a) Discuss the nutrient cycling function of a fresh water flood plain wetland in an arid environment in Southern Africa.
   (b) Discuss problems that may be associated with management of arid flood plain wetlands.

4. Discuss major threats of the following wetlands of Southern Africa:
   (a) Rufigi delta in Tanzania.
   (b) Bangweulu swamps in Zambia.
   (c) Cuanza flood plain in Angola.
   (d) Shire marsh in Malawi.

5. Discuss any <u>two</u> of the following:
   (a) Features which would indicate that a dambo wetland system was being overexploited.
   (b) Estuarine wetland habitats.
   (c) Main functions of wetlands.

6. Discuss each of the following:
   (a) Limitations of management of a fresh water wetland.
   (b) Drivers of overexploitation of wetland species.
   (c) Import and export of wetland ecosystems.

7. Describe each of the following:
   (a) Values of wetland ecosystems.
   (b) Palustrine wetland structure.
   (c) Possible impact of downstream dam development on wetland ecosystems.

TURN OVER

8. Construct and discuss the wetland hydrological model of a riverine wetland environment in Southern Africa.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5341: MOLECULAR MICROBIOLOGY
THEORY PAPER

TIME: THREE HOURS

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

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1. Discuss the structures and roles of different secretion systems in bacteria.

2. Explain bacterial biofilm formation in terms of:
   (a) Attachment.
   (b) Matrix exopolysaccharide types and their roles.
   (c) Di-guanylate monophosphate (c-di-GMP) synthesis and roles.

3. The HIV has complex gene expression regulation mechanisms.
   (a) State six different genes in the HIV genome and describe their functions.
   (b) Discuss the transactivation mechanism of HIV gene expression regulation and the control of P-TEF by 7SK ribonucleoprotein complex and the Tat factor.

4. Discuss the *las* and *rhl* quorum sensing system of *Pseudomonas aeruginosa.*

5. Analyze the auto-inducing peptides of Gram-positive bacteria in terms of structural and functional variations.

6. Discuss gene regulation of pathogenicity islands (PAIs) with reference to the enterocyte effacement (LEE) locus of the enteropathogenic *Escherichia coli* strain 2348/69.

7. Discuss the roles of hybrid histidine kinases in three selected fungal human pathogens.

8. Compare and contrast the Ebola Virus and Marburg Virus in terms of genome structure and organization and explain two approaches to analyze the functions of their viral genes while minimizing the potential for infection.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR
FINAL EXAMINATIONS

BIO 5401: CURRENT THEMES IN MOLECULAR CELL BIOLOGY
THEORY PAPER

TIME: THREE HOURS

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

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1. Explain *three* different mechanisms of gene expression control by eukaryotic activator proteins and use *two* specific examples of your choice to discuss two of the mechanisms.

2. Small RNAs (sRNAs) play important roles in gene expression regulation in prokaryotes and eukaryotes.
   (a) Describe the transcription control mechanism by the 6S RNA of *Escherichia coli.*
   (b) Explain the molecular mechanism of RybB sRNA in one *E. coli* cell metabolic process.

3. Riboswitches have many novel functions in gene regulation in prokaryotic and eukaryotic cells.
   (a) Describe the structure of a riboswitch.
   (b) Explain the molecular mechanism of the *lysC* riboswitch in different lysine conditions in different bacterial cell environments.

4. Compare small interfering RNAs (siRNAs) and micro RNAs (miRNAs) in terms of biosynthesis and their roles in gene expression regulation.

5. Discuss the regulation of miRNAs by p53 in cancer development and control.

6. Discuss the mechanism of gene expression control by synergy between various cellular factors and use the *HO* gene expression regulation to illustrate the mechanism.

TURN OVER

7. Stem cells are maintained by signaling pathways mediated by interactions between proteins in pathways such as the bone morphogenic protein 4 (BMP4), the transforming growth factor beta (TGF-b) and the TFG-b/Activin/Nodal pathway.

   (a) Explain two properties of embryonic stem cells (ESCs).
   (b) Explain two potential benefits of research into stem cells.
   (c) Explain two potential problems which could be encountered in the application of stem cells.
   (d) Discuss the molecular events in transforming growth factor beta (TGF-β) signaling in ESC maintenance including the roles played by various regulators of ESC maintenance in signaling pathways.

8. Distinguish gene silencing by DNA methylation from gene silencing by histone methylation and use one example of gene silencing by DNA methylation in mammals to explain the latter phenomenon.

END OF EXAMINATION

The University of Zambia

School of Natural Sciences

Department of Chemistry

Final Examinations 2015

CHE5011: General Chemistry Techniques

Time: 3 Hours 5th March, 2016

Answer **Question 1**, and any other **THREE (3)** questions

$c = 3.00 \times 10^{8}$ m s^{-1} $h = 6.626 \times 10^{-34}$ J s 1 eV = 1.602×10^{-19} J

Question 1 (20 marks)

(a) Critically compare and contrast HPLC and HPTLC methods. **[5]**

(b) A spectrum from $^{A}_{42}Mo$ x-ray tube operated a 60 kV and current of 20 mA consist of Brensstrahlung radiation and characteristic lines at wavelength of 0.071073 nm and 0.0632229 nm.

(i) Draw a sketch of spectrum. **[2]**

(ii) Calculate the energy at wavelength of 0.071073 nm in keV **[3]**

(c) Suggest the most appropriate technique for purification of the microscale DNA sample and for the microscale tertiary alkaloid sample. **[2]**

(ii) Give three reasons to explain why moving boundary electrophoresis is not a good technique for separation of proteins. **[3]**

(d) (i) The Beer-Lmabert law can be expressed with the following equation:

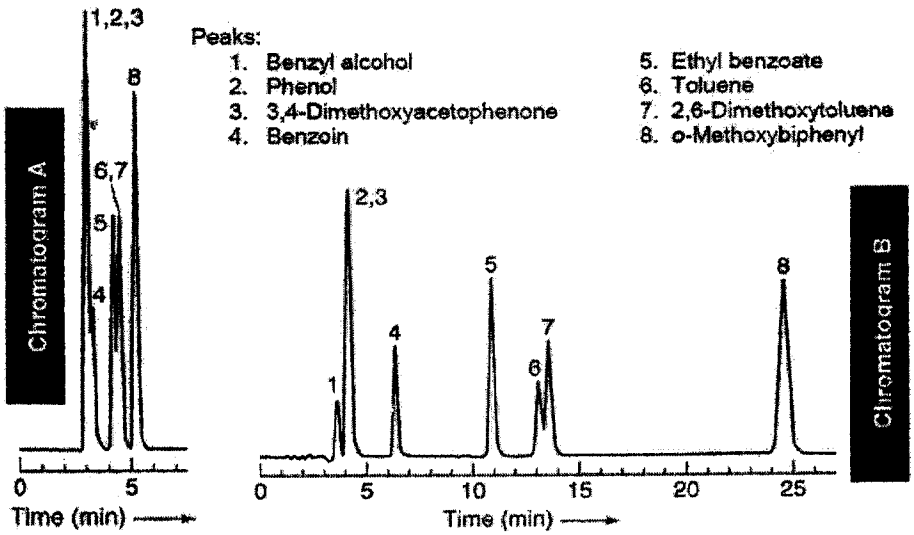
$-Id = \int_{\bar{\nu}_1}^{\bar{\nu}_2} (\propto h\nu) ICdl.$

What is the significance of this equation compared to commonly used equation? **[3]**

(ii) Explain the terms: induced and spontaneous emission **[2]**

Question 2 (20 marks)

This question refers to the reverse phase HPLC chromatograms below



(i) What solvent system is usually best suited for such a method? [2]

(ii) Identify a detector used to detect these compounds and write a detailed note on the principal behind such a detector. [6]

(iii) What stationary phase can you choose to separate these compounds effectively? [2]

(iv) Chromatogram B was recorded on the same column and with the same sample as chromatogram A, but the separation is very different. This is because the mobile phase was changed between the two separations. Explain how the mobile phase was changed to affect the separation so dramatically. Be specific. **[10]**

Question 3 (20 marks)

(a) There are three terms in the van Deemter equation: the A term, the B term, and the C term, each describing a different type of contribution to the band broadening. Explain the type of band broadening described by 2 of the 3 terms. **[10]**

(b) A GC-FID analysis was conducted on a soil sample containing pollutant X. The following separations were conducted:

		tR (minutes)	Peak area
Injection 1	21.1 ppm Toluene Internal Standard	10.11	36242
	33.4 ppm X	14.82	45997
Injection 2	21.1 ppm Toluene Internal Standard	10.05	38774
	Unknown concentration of X	14.77	39115

Calculate the concentration of X. **[10]**

Question 4 (20 marks)

An EDXRF spectrometer with $^{A}_{42}Mo$ x-ray tube operated at 60 kV with a current of 20 mA generating K_α x – rays of 17.46 keV and 925MBq annular $^{109}_{48}Cd$ source generating K_α x – rays of 22.22 keV was used to analyze a pellet containing 1.0000 g soil from Kabwe contaminated with lead. Standard addition method was used to determine the concentration of lead in the soil.

(a) Write two reactions leading to the generation of excitation x-rays using the modes mentioned above. **[4]**

(b) Lead has $K_{\alpha 1}$ and $K_{\alpha 2}$ of 74.969 and 72.804 keV respectively.

(i) Write two equation that gives the above characteristic radiations and define the terms in the equations **[4]**

(ii) Write an expression to show that $K_{\alpha 1}$ and $K_{\alpha 2}$ of Pb cannot occur using Mo tube or $^{109}_{48}Cd$ source, **[2]**

(c) Use the 10.50 keV L_α net peak areas obtained using $^{109}_{48}Cd$ source given in the data below to calculate the concentration of lead in the soil sample in ppm. **[10]**

Mass of Pb (grams)	**Peak area (cps)**
0.0	6.48
0.0050	28.16
0.0100	49.83
0.0150	71.50
0.0200	93.16

Question 5 (20 marks)

(a) (i) Draw the labelled **diagram for microscale distillation apparatus and briefly** describe the procedure for microscale distillation. **[8]**

(ii) How would you determine the purity of the distilled sample? **[2]**

(b) The efficiency of separation (N) in capillary electrophoresis (CE) is given by the expression given below. However, application of very high potentials (>20-30 kV) in CE separations leads to loss of resolution.

$$N = \frac{\mu V}{2D_m}$$

(i) Define the terms in the above equation. **[3]**

(ii) Briefly explain how use of high potentials leads to loss of resolution in CE. **[3]**

(i) Briefly explain the principle of the PAGE technique. **[4]**

Question 6 (20 marks)

(a) Explain in brief the following in relation to lasers:
(i) Active medium **[2]**
(ii) Excitation mechanism **[2]**
(iii) High reflectance and partially transmissive mirror **[2]**

(b) (i) Draw a sketch diagram of the construction of a basic He-Ne laser **[3]**
(ii) Outline in brief the mechanism involved in the production of laser radiation **[2]**

(c) Define the following terms: (i) fluorescence. (ii) phosphorescence. (iii) singlet and triplet state. **[4]**

(d) How do you collect a fluorescence emission spectrum? Explain how the spectra obtained can be used for structure elucidation of organic compounds. Used suitable diagrams to explain. **[5]**

explain how each of the three scheduling schemes work, clearly distinguishing between them.

[15 marks]

SECTION B: Answer ANY TWO of the THREE Questions

2. a) What are the two formidable problems that designers must solve to implement a network-transparent system?

[15 marks]

b) Explain the concept of a synonym and demonstrate how you would use synonyms in the DBMS environment to achieve network transparency, location transparency and fragmentation transparency.

[10 marks]

3. a) Multi-programming (or multi-tasking) enables more than a single process to apparently execute simultaneously. How is this achieved on a single processor?

[15 marks]

b) With the aid of a diagram or an elaborate algorithm where possible, explain how the producer/consumer problem could be implemented using multiprogramming techniques in a distributed environment.

[10 marks]

4. a) Database links could be used to implement a distributed information systems and may support distribution transparencies in a distributed environment. You have been asked to design a distributed systems environment to write appropriate code to demonstrate how you can implement the following transparencies.

- Location transparency
- Network transparency
- Naming transparency

Full marks will only be given for answers that show code and the role that code plays in realizing the said transparencies.

[15 marks]

b) Write a function that returns the explanation for the name of a given year of based on the following rules. If the year = 1, then return 'FIRST YEAR', if the year = 2, then return 'SECOND YEAR', if the year = 3 then return 'THIRD YEAR', if the year = 4 then return 'FOURTH YEAR' else return 'UNKNOWN'. Your function should return all values as encoded in the problem statement while maintain the case sensitivity required in Oracle..

[10 marks]

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
Department of Computer Science

PROGRAMMING LANGUAGES
CSC 5021

2015-2016 FINAL EXAM

Date: 3rd March 2016
Venue: Computer Hardware Lab
Time: 09hrs
Duration: 3 Hours

Instructions

1. This exam contains two (2) sections.
2. Answer **all** questions in section A
3. Answer **any**two (2) questions in section A
4. Write your answers on a separate answer sheet

SECTION A

Answer all questions in this section [60 Marks]

1. Analyze the java code below and answer the questions that follows;

```
public class Welcome{
  public static void main(String args[]){
      //variable declaration
      int i = 2;
      int j = 3;

      //arithmetic
int sum = i + j;
      int difference = i - j;
      int product = i * j;
int quotient = i / j;

      //print
      System.out.println(sum);
      System.out.println(difference);
      System.out.println(product);
      System.out.println(quotient);
  }
}
```

a) What is a java keyword? [1 Mark]
b) Identify all java keywords in the above code [4 Marks]
c) List twenty (20) other java keywords not listed in code above [10 Marks]
d) What is a java identifier? [1 Mark]
e) Identify all identifiers in the above code [12 Marks]
f) What is a java comment? [1 Mark]
g) List and explainthree (3) java comment [3 Marks]
h) What is the output if the above code is compiled and run? [2 Marks]

2. Analyze the piece of java code below;

```
int i = 0;
while(i>= 5{
   if(i == 0){
      break
   }else{
      System.out.print(i*i);
i++;
}
}
```

a) Identify and correct all the syntax errors in the above java piece of code [3 Mark]
b) List and explain three (3) java selection control statements [3 Marks]
c) Rewrite the above piece of code using a for control statement [4 Marks]

d) Rewrite the above piece of code using a do while control statement [4 Marks]

3. Study the inheritance hierarchy below and answer all the questions below;

```
public class Person{
    protected String name;

    public Person(String n){
       name = n;
    }
   public void codee(){
      System.out.println("I am a person");
   }
}

public class Alpha extends Person{
    private String location;
    public Tints(String n,String l){
         super(n);
         location = l;
    }
}
```

a) Explain java Inheritance [1 Mark]
b) Explain java polymorphism [1 Mark]
c) List all behaviors of the Alpha class? [1 Mark]
d) List all the attributes of the Alpha class? [1 Mark]
e) Write a class called PersonTest with the main method. Create two objects of Alpha class and call codee method on both objects. Create a third object from Alpha class and demonstrate polymorphism. [8 Marks]

SECTION B

Choose any two (2) questions. Each question is worth 20 marks.

1. Write a java program that prompts a user for two (2) integers. Read the numbers using the Scanner class and divide the two integers and print the quotient. Handle all the possible exceptions in your code using the try and catch. If an exception occurs, your program must give an appropriate error message to the user and loop through again to ask the user to re-enter the numbers. If no exception occurs, the program must print the quotient and exit. [20 Marks]

2. Beforward Zambia stocks thousands of Vehicles for sale. A vehicle at Beforward can move, hoot, and park. Beforward keeps the following information about Vehicles, name, make, year of manufacture and mileage. A BMW is one of the Vehicles Beforward stocks. A BMW can cruise and change gear. Beforward also tracks the number of gears the BMW has.
    a) Represent the above scenario using java inheritance (for simplicity, just print the name of the method in all the methods identified) [16 Marks]
    b) Create two (2) BMW cars and make them move [4 Marks]

3. Create a java class called Adder. Adder must define the main method. Inside the main method, declare two variable; first number and last number. Initialize first number with 10 and initialize second number with 20. Add first number variable with second number variable and store the sum in a variable called sum. Finally print sum with println, print and printf. [20 Marks]

4. Create a class that holds 10 grades in an array data structures.[2 Marks]
    a) Loop through the data structure and compute the sum of grades [2 Marks]
    b) Loop through the data structure and compute the average of grades [4 Marks]
    c) Loop through the data structure and print the biggest grade [4 Marks]
    d) Loop through the data structure and print the lowest grade [4 Marks]
    e) Print the grades in the descending order of indexes [4 Marks]

THE UNIVERSITY OF ZAMBIA

School of Natural Sciences

Department of Computer Science

MACHINE ARCHITECTURE AND OPERATING SYSTEM
CSC 5111
2015-2016 FINAL EXAM

Date: 10th March, 2016
Venue: Computer Hardware Lab
Time: 14hrs-17hrs
Duration: 3 Hours

Instructions

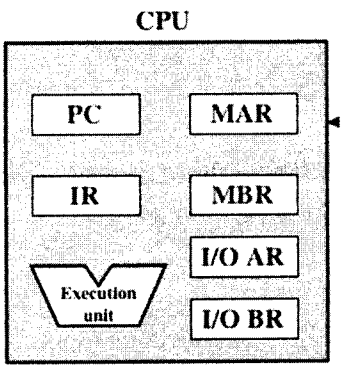
1. There are **seven questions** in this exam.
2. Attempt **any five (5)** questions.
3. All questions carry **equal** weight of **20 marks**.
4. Write your answers on a separate answer sheet

QUESTION 1 [20 Marks]

1. In general terms, what is the distinction between computer structure and computer organization? **[4 Marks]**
2. List and briefly define the main structural components of a computer. **[4 Marks]**
3. Give the binary representation of the following decimal numbers. **[4 Marks]**
   a. 76 b. $\frac{2}{5}$
4. Convert the following binary numbers to their hexadecimal equivalents: **[4 marks]**
   a. 111001 b. 1000101
5. Consider a memory organization with a 32-bit memory addresses and word length of 8 bytes. What is the second byte number of the fifth last word? **[4 marks]**

QUESTION 2 [20 Marks]

1. State and explain the four (4) classes of interrupts. **[4 Marks]**
2. What is the control bus and what kind of signals can it transmit? **[4 Marks]**
3. Consider the diagram below. Define and state the function of each components. **[6 Marks]**



4. What is the general relationship among access time, memory cost, and capacity?**[3 Marks]**
5. State two (2) key characteristics of semiconductor memory. **[3 Marks]**

QUESTION THREE [20 Marks]

1. State and explain the four (4) cache replacement algorithms for block mapping. **[8 Marks]**
2. What is the function of the memory management unit **[2 Marks]**
3. What are the differences among EPROM, EEPROM, and flash memory? **[5 Marks]**
4. Draw a well labelled diagram depicting the basic instruction cycle in the computer system. **[5 Marks]**

QUESTION FOUR [20 Marks]

1. In terms of characteristics like, speed, size, and cost, how does DRAM and SRAM differ? **[6 Marks]**
2. Explain the difference between DRAM and SRAM in terms of application? **[4 Marks]**
3. What are the differences among sequential access, direct access, and random access? **[5 Marks]**
4. Draw a well labelled diagram depicting a three level cache organization. **[5 Marks]**

QUESTION FIVE [20 Marks]

1. Explain why it is desirable to use glass substrate for a magnetic disk? **[5 marks]**
2. Define the terms **track**, **cylinder**, and **sector**. **[3 marks]**
3. What is the typical disk sector size? **[2 mark]**
4. Define the terms **seek time**, **rotational delay**, **access time**, and **transfer time**. **[4 marks]**
5. What common characteristics are shared by all RAID levels? **[6 Marks]**

QUESTION SIX [20 Marks]

1. State and explain the three (3) broad classifications of external or peripheral, devices.**[3 marks]**
2. List the 5 major functions of an I/O module? **[5 marks]**
3. List and briefly define three techniques for performing I/O operations. **[6 marks]**
4. Draw a well labelled diagram depicting the generic model of an I/O module. **[6 Marks]**

QUESTION SEVEN [20 Marks]

1. Consider a single-platter disk with the following parameters: rotation speed: 7200 rpm; number of tracks on one side of platter: 40,000; number of sectors per track: 800; seek time: 1.5 **ms** for every hundred tracks traversed. If the disk received a request to access a random sector on a random track.

   a. What is the average seek time? **[4 Marks]**

   b. What is the average rotational latency? **[2 Marks]**

   c. What is the transfer time for a sector? **[2 Marks]**

   d. What is the total average time to satisfy a request? **[2 Marks]**

2. What differences between a CD and a DVD account for the larger capacity of the latter? **[6 marks]**
3. What are some applications for ROM? **[4 marks]**

--> END <--

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

University Semester I Examinations March 2016

MSc Computer Science

CSC 5231: Advanced Web Technologies

Time: Three hours

Answer four questions

All questions carry equal marks

Question 1

a) Discuss the historical developments of the Wide World Web with reference to its protocols and associated technologies. **[15 marks]**

b) Outline some of the differences between HTML and XHTML. **[5 marks]**

c) What role does CSS play in Web applications development and give some example tags in use. **[5 marks]**

Question 2

a) What do you understand by the term "Server Side Technonologies"? List a few technologies that are referred to as Backend Technologies and a few Frontend Technologies. **[8 marks]**

b) What are JSP's and what is a Servlet. Discuss the JSP life cycle? **[6 marks]**

c) What are JSP scriplets and what role do they play in a JSP file? **[3 marks]**

d) In the listed JSP code below, discuss what happens if the file was run?

```
<HTML>
  <BODY>
      Hello world! The time is now <% = new java.util.Date() %>
  <BODY>
<HTML>
```

[2 marks]

e) In the JSP parlance, how would your declare a JSP Directive, JSP Declaration and a JSP Expression. **[6 marks]**

Question 3

a) What is/are WebServices, and briefly describe some of the characteristics of webservices?

[6 marks]

b) A basic Webservice platform may be viewed as "XML + HTML". What three technological components actualize webservices? **[6 marks]**

c) With respect to Restful webservices, discuss how Restful services reuse the core HTTP protocol method calls for the service to be operational (recall, HTTP is stateless). **[13 marks]**

Question 4

a) List at least four image formats in general use and describe properties of at least two of the mentioned image formats. **[12 marks]**

b) What is a Pixel vis-a-vis digital images and how does colour depth relate to image resolution and overall bearing on image size? **[8 marks]**

c) ZamZim Reprographics, a multimedia company is seeking to create a low budget animation. What image format would you recommend and what Open Source software would you equally recommend that they use for image manipulation? **[5 marks]**

Question 5

a) What is XML? Explain its role in system integration, advantages and disadvantages of its use.

[10 marks]

b) What are XML Schemas and what are their significance in data modeling and description?

[5 marks]

c) What are namespaces and how would you use them in XML Schemas? **[5 marks]**

d) Discuss DOM and SAX parsers. **[5 marks]**

Question 6

a) Audio/Video (AV) entails processing both sound and visual data. The sheer volume of data involved makes these files cumbersome, particularly when it comes to transmission or storage. Many audio and video file formats employ codecs. What is a codec?

Some codecs are said to be "lossy". What is meant by the term lossy? **[10 marks]**

b) Discuss the term "Streaming" with respect to audio/video data and in particular buffering.

[6 marks]

c) What is multicasting and how would you utilize multicasting in transmitting streaming content in order to optimize network bandwidth? **[4 marks]**

d) As a home enthusiast, you are embarking on creating you own streaming media content, describe how you would go about the task up until the file is uploaded to your streaming server.

[5 marks]

The University of Zambia Examination 2016

Information Coding Techniques CSC 5132

Time: 3 Hours

Instructions: Read instructions for each section

Section 1: Multiple Choice
(20 marks)
Answer all (select 1)

1. Which of these is not true about information?
    a. Information is objective
    b. Information is subjective
    c. Information can be lost
    d. Information can be measured
2. How many possible codes can be represented by a 6 bit code representation?
    a. 6
    b. 32
    c. 256
    d. 64
3. How many bits represent an IP address?
    a. 8
    b. 16
    c. 32
    d. 64
4. How many bits represent the ASCII code?
    a. 7
    b. 8
    c. 16
    d. 4
5. LZW compression is
    a. Lossy
    b. Lossless
    c. Irreversible
    d. Based on a static dictionary

Section 2: Short answer. Answer all. (5 marks each)

1. List the different ways in which spare capacity can be used in a code?
2. Exlain what is meant by binary coded decimal (BCD) and create a table showing how it is coded?
3. What are advantages of using fixed length codes versus variable length codes.
4. Itemize at least three different compression technique and explain how they work?
5. Define entropy and write down it equation?
6. When does minimum and maximum entropy occur?

Part three (Answer any two questions)

1. Use the LZW algorithm to compress the following data.

ba obama banana

2. An alphabet contains the five symbols {A, B, C, D, E}, which appear with probabilities p(A) = 1/4 , p(B) = 1/4 , p(C) = 1/8 , p(D) = 1/8 , p(E) = 1/8 . Design a binary Huffman code for this alphabet.
3. A source produces a character x from the alphabet A = {0, 1, 2, · · · 9, a, b, c, · · · , y, z}; with probability 1/3, x is a numeral {0, 1, 2 · · · , 9}, with probability 1/3, x is a vowel {a, e, i, o, u}; and with probability 1/3 it's one of the 21 consonants. All numerals are equiprobable, and the same goes for vowels and consonants. Determine the entropy of X.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

School of Natural Science

Department of Computer Science

FINAL EXAMINATION

CSC 5491: SOFT COMPUTING

Date:	Tuesday, 8th March 2016
Time:	09:00hrs – 12:00hrs
Duration:	3 Hours
Venue:	Computer Lab 3

Instructions

1. There are **six (6) questions** and **two (2) sections** in this paper.
2. Each question carries **20 marks,**
3. *You are required to answer a total of **Five (5) Questions***
   a. *Answer **all** the questions in **Section A***
   b. Choose ***any three (3)** questions from **Section B***

SECTION A

This section has Three questions. Answer all the questions

Question I

a) Define each of the following terms [4 Marks]

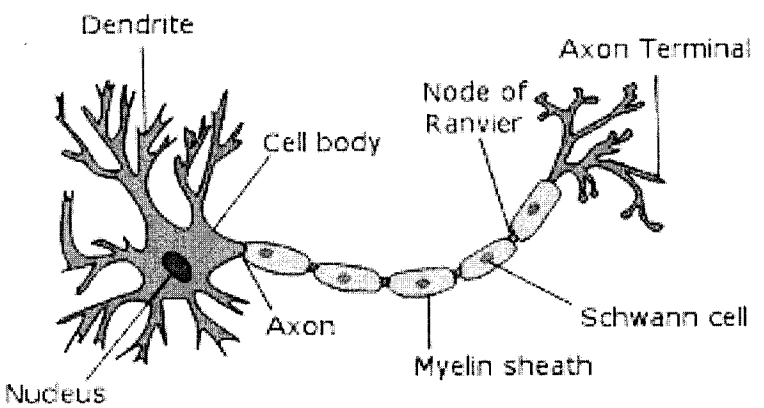
i. Soft Computing
ii. Expert Systems
iii. Hedges
iv. Knowledge Base

b) MATLAB is a numerical computing environment and programming language which was created by The MathWorks. It allows easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages. Give any four advantages of using MATLAB software tool [4 Marks]

c) Soft computing differs from conventional (hard) computing in several ways. The role model for soft computing is actually the human mind. Give a brief description for each of the following terms [6 Marks]

i. Soft Computing
ii. Hard Computing
iii. Expert Systems

a) The diagram below shows the biological neuron. Draw a well labelled diagram of the **artificial neuron** and explain how it works in comparison to the biological neuron [6 Marks]



Question II

a) MATLAB comes with a number of built in Function that can be used to manipulate a matrix. Give the output of the following functions [4 Marks]

i. A = zero(5)

ii. B = [0:2:30]

b) Encoding is the process of representing the solution in the form of a string that conveys the necessary information. Just as in a chromosome, each gene controls a particular characteristic of the individual; similarly, each bit in the string represents a characteristic of the solution. With reference to genetic algorithm encoding, give a brief description of the following encoding mechanisms [6 Marks];

i. Binary Encoding

ii. Permutation Encoding

iii. Value Encoding

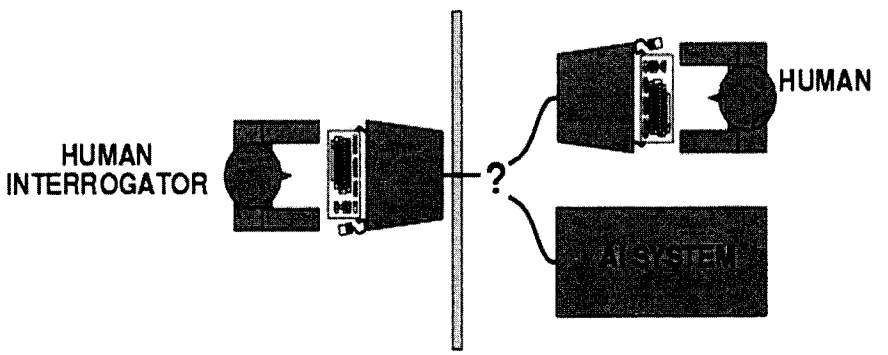
c) In the fuzzy theory, fuzzy set A of universe X is defined by function $\mu_A(x)$ called the membership function of set A. Write down the membership function $\mu_A(x)$ [2 Marks]

d) Let X be the universe of discourse and its elements be denoted as x. In the classical set theory, crisp set A of X is defined as function $f_A(x)$ called the characteristic function of A. Give the function $f_A(x)$ [2 Marks]

d) The diagram below shows a Full Turing Test. [6 Marks]

i. Describe a Turing Test

ii. What would a computer need to pass the Turing test?



Question III

a) Define the following in relation to MATLAB [2 Marks]

i. Vectors

ii. Variable

b) The snap code below is used to create the neural network. Give the function of each of the lines of MatLab Code shown [3 Marks]

```
1. net = network;
2. net.numInputs = 4;
3. net.numLayers = 5;
4. net.biasConnect(1) = 1;
5. net.inputConnect(1,1) = 1;
6. net.inputs{1}.range = [0 10];
```

c) Create and write down the MatLab code using the Perceptron Network to perform the following functions [6 Marks]

i. Logic **AND** function

ii. Logic **OR** function

Sketch the diagram showing the actual **Perceptron Network** for (1) and (2) above.

d) List the three basic entities of artificial Neuron Network (ANN) models [3 Marks]

e) You can create matrices (arrays) of any size using a combination of the methods for creating vectors. One of the methods is by using a comma to separate each column and then a semi colony to define a new row as shown below for the results matrix.

```
>> Results = [1, 0.5, 0.6, 0.3; 2, 0.3, 0.33, 0.75;
              3, 0.54, 0.2, 0.99; 4, 0.7, 0.6, 0.1;
              5, 0.89, 0.73, 0.3; 6, 0.2, 0.9, 0.94;
              7, 1, 0.4, 0.3]
```

What is the output of the following operations using the matrix above [6 Marks]

i. results (3:5,;)

ii. results (4,;)

iii. results(:, 5) = results(:, 3) + results(:, 4)

SECTION B

This section has four Questions. Choose any two questions

Question I

a) Define the following terms [2 Marks]
   i. Linguistic variables
   ii. Neuron

b) Name and give any four areas where artificial neural networks have been successfully applied [2 Marks]

c) What is the major Guiding Principle of Soft Computing? Discuss the premises and guiding principles of Hard Computing [4 Marks]

d) The three Learning Rules used by Artificial neural network include;
   i. Supervised learning
   ii. Reinforcement learning
   iii. Unsupervised learning

   With the **aid of the diagram**, **discuss** each of the three learning rules [6 Marks]

e) The processing elements of ANN constitute of the integration functions and activation functions.
   i. Give the names of 1 example of the integration function and 1 examples of Activation function [2 Marks]
   ii. Write down the functions of the names in (i) above [4 Marks]

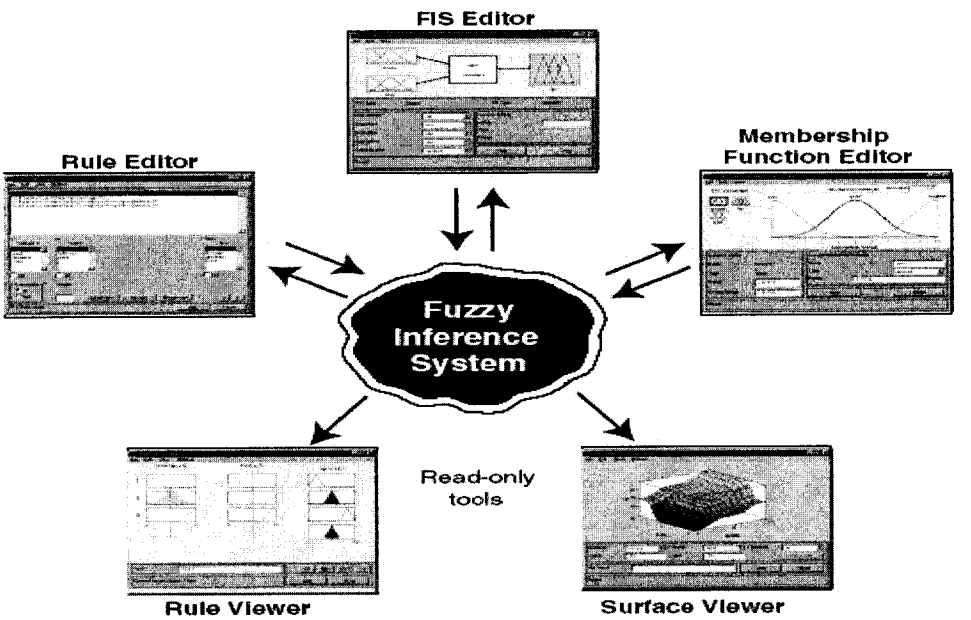
Question II

a) Compare and contrast with examples between [3 Marks]
   i. Boolean Logic and Fuzzy Logic
   ii. Crisp Set and the Fuzzy Set

b) If A, B are fuzzy sets with membership functions μA, μB, respectively, and defined for $x \in U$. Give the fuzzy set for the following [3 Marks]
   i. Complement $\sim A$
   ii. Union $A \cup B$
   iii. Intersection $A \cap B$

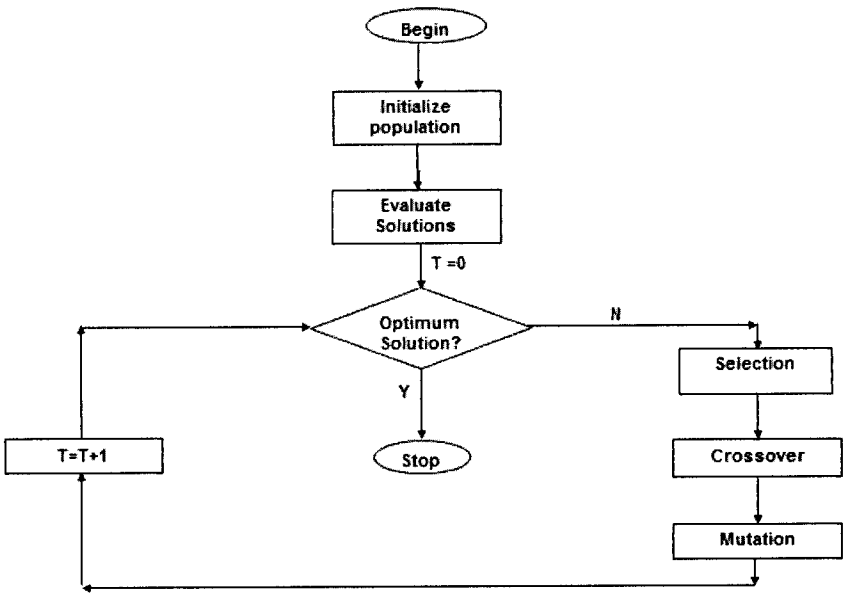
c) Name and give any the ***two (2) main Fuzzification Functions*** used in Fuzzy inference systems [4 Marks]

d) MATLAB fuzzy logic toolbox provides five primary GUI tools to work with Fuzzy Inference System (FIS) as shown in the diagram below. Give a brief description for each of the following five primary GUI tools [10 Marks]
   i. Fuzzy Inference System (FIS) Editor
   ii. Membership Function Editor
   iii. Rule Editor
   iv. Rule Viewer
   v. Surface Viewer



Question III

a) The diagram below shows the conceptual view of the genetics algorithm. With reference to the diagram, give a brief description of basic concepts and operation of genetics algorithm [4 Marks].



b) The Table below shows the comparison between nature and the computer implementation of genetic algorithm. Complete the Table [4Marks]

#	Nature	Computer
1	Population	Set of solutions.
2	Individual	Solution to a problem.
3	Fitness	
4	Chromosome	
5		Part of the encoding of a solution.
6	Reproduction	

c) Briefly discuss each of the following terms in relation to genetics algorithms [6]

i. Fitness Function
ii. Recombination
iii. Roulette Wheel Selection

d) Give any three advantages of using genetics algorithms over other methods [3 Marks]

e) Crossover is the process in which two chromosomes (strings) combine their genetic material (bits) to produce a new offspring which possesses both their characteristics. Two strings are picked from the mating pool at random to cross over. The method chosen depends on the Encoding Method. Give any three cross over methods used in genetic algorithm [3 Marks]

THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
Department of Computer Science

DATABASES AND INFORMATION SYSTEMS
CSC 5711

2015-2016 FINAL EXAM

Date: 1st February 2016
Venue: Computer Hardware Lab
Time: 09hrs-12hrs
Duration: 3 Hours

Instructions

1. This exam contains two (2) sections.
2. Answer **all** questions in section A
3. Answer **any** two (2) questions in section B
4. Write your answers on a separate answer sheet

SECTION A

ANSWER ALL QUESTIONS IN THIS SECTION

Marks

QUESTION 1 **8**

a) Explain the following terms briefly:
domain, entity,relation schema,equijoin

QUESTION 2

a) In your own words, briefly describe the circumstances under which transactions wouldbe a desirable option when interacting with a MySQL database. **6**

QUESTION 3

Suppose that the Authoring relation was created as follows:

```
CREATE TABLE Authoring (
articleID INT REFERENCES Article (ID) ON DELETE SET NULL,
authorID INT REFERENCES Author (ID) ON DELETE CASCADE
)
```

a) Indicate which of the following statements are true, and which are not. Use the answer sheet of the exam for your answer.

1. If we try to delete a tuple from Authoring, the tuple is not deleted. Instead, articleID is set to NULL. **1**

2. If we delete a tuple from Authoring, any tuples in Author referred to by this tuple are also deleted. **1**

3. If we delete a tuple from Article, some attributes of Authoring may have their values set to NULL. **1**

4. If we try to insert a tuple into Author, with an ID that is not referred to in Authoring, the operation is rejected. **1**

5. If we try to insert a tuple into Authoring, with an ID that does not exist in Author, the operation is rejected. **1**

QUESTION 4

Design an E-R diagram for keeping track of the exploits of your favoritesports team. You should store the matches played, the scores in each match,the players in each match, and individual player statistics for each match. **8**

QUESTION 5

List the ACID properties. Explain the usefulness of each **8**

QUESTION 6

SQL allows a foreign-key dependency to refer to the same relation, as in the following example:

create table *manager*
(*employee_name***varchar**(20) **not null**
*manager_name***varchar**(20) **not null**,
primary key *employee_name*,
foreign key (*manager_ name*) **references** *manager* **on delete cascade**)

Here, employee name is a key to the table manager, meaning that each employee has at most one manager. The foreign-key clause requires that everymanager also be an employee. Explain exactly what happens when a tuplein the relation manager is deleted.

5

Total 40 Marks

SECTION B

ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION 1 **Marks**

For this question use the tables given below:

Books

book_id	title	author
1	Way We Live Now	Anthony Trollope
2	Dual	Giacomo Casanova
3	Wuthering Heights	Emily Bronte
4	My Friend Maigret	Georges Simenon
5	Dracula	Bram Stoker
6	Moby Dick or the Whale	Herman Melville
7	Power and the Glory	Graham Green
8	Years	Virginia Wolf
9	Oliver Twist	Charles Dickens
10	Emma	Jane Austen

Members

mem_id	fname	lname
100	Mel	Gibson
101	Kenneth	Branagh
102	Keifer	Sutherland
103	Bert	Newton
104	Ray	Liota
105	John	Cusak

Loan_Data

book_id	mem_id
2	101
4	103
5	105
8	100
7	104

Write SQL queries for the following questions below:

a) What book/s does member 103 have out, if any? **5**

b) The names and numbers of those with no books out? **5**

c) Books in stock but not checked out to anyone? **5**

d) Books currently checked out, together with the name of the member they've been checked out to? **5**

e) Locate the titles of books in the books table that have been written by the same author: **10**

Total 30 Marks

QUESTION 2 **Marks**

The academic world is an interesting example of international cooperation and exchange. This problem is concerned with modeling of a database that contains information on researchers, academic institutions, and collaborations among researchers. A researcher can either be employed as a professor or a lab assistant. There are three kinds of professors: Assistant, associate, and full professors. The following should be stored:

- *For each researcher, his/her name, year of birth, and current position (if any).*
- For each institution, its name, country, and inauguration year.
- For each institution, the names of its schools (*e.g. School of Law, School of Business, School of Computer Science,. . .*). A school belongs to exactly one institution.
- An employment history, including information on all employments (start and end date, position, and what school).
- Information about co-authorships, i.e., which researchers have co-authored a research paper. The titles of common research papers should also be stored.
- For each researcher, information on his/her highest degree (BSc, MSc or PhD), including who was the main supervisor, and at what school.
- For each professor, information on what research projects (title, start date, and enddate) he/she is involved in, and the total amount of grant money for which he/shewas the main applicant.

a) Draw an E/R diagram for the data set described above. Make sure to indicate all cardinality constraints specified above. The E/R diagram should not contain redundant entity sets, relationships, or attributes. Also, use relationships whenever appropriate. If you need to make any assumptions, include them in your answer. **15**

b) Convert your E/R diagram from question **a)** into relations, and write SQL statements to create the relations. You may make any reasonable choice of data types. Remember to include any constraints that follow from the description of the data set or your E/R diagram, including primary key and foreign key constraints.

15

Total 30 Marks

SECTION B

ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION 1 **Marks**

For this question use the tables given below:

Books

book_id	title	author
1	Way We Live Now	Anthony Trollope
2	Dual	Giacomo Casanova
3	Wuthering Heights	Emily Bronte
4	My Friend Maigret	Georges Simenon
5	Dracula	Bram Stoker
6	Moby Dick or the Whale	Herman Melville
7	Power and the Glory	Graham Green
8	Years	Virginia Wolf
9	Oliver Twist	Charles Dickens
10	Emma	Jane Austen

Members

mem_id	fname	lname
100	Mel	Gibson
101	Kenneth	Branagh
102	Keifer	Sutherland
103	Bert	Newton
104	Ray	Liota
105	John	Cusak

Loan_Data

book_id	mem_id
2	101
4	103
5	105
8	100
7	104

Write SQL queries for the following questions below:

a) What book/s does member 103 have out, if any? **5**

b) The names and numbers of those with no books out? **5**

c) Books in stock but not checked out to anyone? **5**

d) Books currently checked out, together with the name of the member they've been checked out to? **5**

e) Locate the titles of books in the books table that have been written by the same author: **10**

Total 30 Marks

QUESTION 3 **Marks**

a) Given the following form produce an un-normalised data set.**4**

VIRGIN CD STORE SALES SHEET

store Number: 123-1231 Store Name: Mount Lawley

Staff#	Staff Name	CD Name	Artist	Price	Cust#	Surname
12343	Melanie C	Mad Season	Matchbox 20	21.99	123	Thomas
12255	Leigh T	Gatecrasher	Various	23.50	124	Smith
23782	Tiffany F	Toca	Fragma	29.95	123	Thomas

b) After checking the data set you created for the above question, normalise to **3NF** (showing all working) and name the final data sets.**12**

c) List three properties of a relation **3**

d) Explain briefly the steps used to convert a data set in 2NF into ones in third normal form(3NF) **5**

e) Explain insertion, deletion and update anomalies. Give an example of each anomaly**6**

Total 30 Marks

END OF PAPER

THE UNIVERSITY OF ZAMBIA
School of Natural Science
Department of Computer Science

FINAL EXAMINATION

CSC 5802: MOBILE COMPUTING AND NETWORK

Date:	Tuesday, 11th March 2016
Time:	09:00hrs – 12:00hrs
Duration:	3 Hours
Venue:	Computer Hardware Lab

Instructions

1. There are seven (7) questions and two (2) sections in this paper.
2. You are required to answer a total of Five (5) Questions
3. Each question carries 20 Marks
4. Answer all the questions in Section A
5. Choose any two (2) questions from Section B

SECTION A

This section has Three Questions. Answer all the questions

1. Question 1: Media Access Control [20 Marks - Question Total]

Media Access Control (MAC) coordinates transmission between users sharing the spectrum in order to prevent collisions while maximizing throughput and minimizing delay. Many different systems exist to control medium access in wireless networks including SDMA, TDMA, FDMA, and CDMA.

a) Explain the fundamental mechanism employed by each of the four media access control systems cited above. [8]
b) What is the basic prerequisite for applying FDMA? And how does this factor increase complexity compared to TDMA systems? [4]
c) Explain the term interference in the space, time, frequency, and code domain and the corresponding countermeasures in SDMA, TDMA, FDMA, and CDMA systems. [6]
d) Describe the "hidden terminal problem" and explain why Ethernet-type collision detection mechanisms won't work in wireless setup.[4]

2. Question 2: Mobile communication systems [20 Marks - Question Total]

Global System for Mobile Communications (**GSM**) is one of the mostly used digital cellular technology for transmitting mobile voice and data services.

a) Describe the three main service domains offered by GSM system. [6]
b) One fundamental feature of the GSM system is the automatic localization of users. The system always knows where a user currently is. Explain how the GSM system makes this possible. [4]
c) Describe factors in the design of the GSM system that makes worldwide roaming possible. [2]
d) Market survey indicates that many future applications for mobile communications will be data driven. Taking this into consideration new technologies other than GSM have emerged to address this market requirement. Explain the limitations inherent in GSM technology which has made it less favorable hence its being replaced and the fundamental features of the successor technologies. [10]

3. Question 3: Mobile phone communication networks [20 Marks - Question Total]

Commercial Mobile phone communication networks use a cellular communication system consisting of geographic sectors called *cells*.

a) What are the main reasons and benefits of using cellular systems in mobile communication networks? [8]
b) How do cellular systems typically accommodate multiple users; [4]
c) What happens to the transmission quality of connections if the load gets higher in a cell, i.e., how does an additional user influence the other users in the cell? [4]
d) Describe how frequency re-use is accomplished in cellular networks. [4]

SECTION B

ANSWER ANY TWO QUESTIONS IN THIS SECTION.

4. Question 4: Fundamentals of Radio Frequencies and Antennas [20 Marks - Question Total]

As a Radio Frequency signal is propagated through the air and other different mediums, it can move and behave in different manners.

a) Describe the main factors that affect the propagation of radio signals (at least four) and how these may lead to fading. [8]
b) Explain why signals with a very low frequency are able to follow the earth's surface.[2]
c) Explain factors that make signals with low frequencies not commercially ideal to be used for transmission in mobile communication networks. [4]
d) How can the design of antennas be modified to mitigating impact of propagation (Explain why each of the three possible design gives the corresponding outcome).[6]

5. Question 5: Mobile communication systems [20 Marks - Question Total]

In commercial mobile communication systems, the design of the network is highly influenced by a number of factors which ultimately affects the size of cells in the network.

a) Explain some of the factors that influence how mobile network are designed and why cell sizes may differ for the same network. [6]
b) In mobile communication networks what is the concept known as handoff and why is it important. [4]
c) What limits the number of simultaneous users in a TDM/FDM system like GSM compared to a CDM system? [4]
d) CDMA systems are being proposed for increased cellular system capacity. What are the main factors that lead to higher capacities in CDMA systems when compared to FDMA or TDMA systems? [6]

6. Question 6: Mobile application computing [20 Marks - Question Total]

Mobile apps are designed with consideration for the demands and constraints of the devices and also to take advantage of any specialized capabilities they have.

a) List five challenges faced in mobile applications development and what consideration has to be made to respectively mitigate the impact of each one of them to make the applications portable. [10]
b) Consider applications developed on Android Platform and explain why it is easy to integrate with inbuilt specialised features like the many optional hardware components, including still or video cameras, GPS, orientation sensors, dedicated gaming controls, thermometers, and touchscreens. [5]
c) As developing countries Zambia inclusive look for innovative solutions in bridging up the information gap in the hope of accelerating development, mobile applications have been repeatedly hailed as having a potential to play critical role. Describe how mobile applications may play a significant role in realising that aspiration. [5]

7. Question 7: Multiplexing techniques [20 Marks - Question Total]

Multiplexing techniques are used to allow many users to share a common transmission resource. In our case the users are mobile wireless gadgets and the transmission resource is the radio spectrum. Sharing a common resource requires an access mechanism that will control the multiplexing mechanism.

a) Describe the four mechanisms that are widely used for multiplexing in mobile communication, for each clearly explain how it works and give the respective advantages and disadvantages. Finally also provide typical application for each mechanism. [20]

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2015 ACADEMIC YEAR FINAL EXAMINATIONS

GES 5365: CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT

TIME: **Three hours**

INSTRUCTIONS: **Answer any FOUR questions**
All questions carry equal marks

---

1. Discuss the Gaia hypothesis in relation to its views on the occurrence of climate change and sustainable development.

2. About 95% of all road transportation depends on oil, which corresponds to 60% of the world's total oil consumption' (UNEP, 2011). Suggest options that can transition the transport sector from 'brown' to 'green'.

3. The 2015 Paris Agreement on climate change has been described by most of the parties as one of the most successful outcomes in the history of climate change negotiations. Discuss the key outcomes from the Paris summit and their implications for limiting global warming to 2°C or 1.5°C by the end of the century.

4. Describe at least five principles that must be considered when formulating a climate change policy.

5. Describe two mitigation and two adaptation measures that Zambia has proposed to implement in her Intended Nationally Determined Contribution (INDC). To what extent do these measures adequately address the effects of climate change that the country is currently facing?

6. Discuss the link among climate change, sustainable development and poverty reduction.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF MATHEMATICS AND STATISTICS
POSTGRADUATE DIPLOMA IN ACTUARIAL SCIENCE
BUSINESS ECONOMICS (MAT 5075)
2015 ACADEMIC YEAR FINAL EXAMINATION

TIME ALLOWED: THREE HOURS

INSTRUCTIONS TO THE CANDIDATE

1. *Enter your computer number on the answer booklet*
2. *You must not start writing your answers in the booklet until you are told to do so by the invigilator*
3. *Mark allocations are shown in brackets. Each multiple choice question carries 1 mark*
4. *Attempt all 40 questions*
5. *show calculations and well labelled graphs were appropriate*

1) Which of the following is correct? The concept of scarcity means that resources:

a) are not available in sufficient quantities to satisfy any individual's wants

b) are not available in sufficient quantities to satisfy all wants for them

c) cannot be increased in quantity to any significant extent

d) are of primary importance in satisfying the wants of society.

2) It has been said that the fundamental fact of scarcity is no longer applicable to the US economy. Which of the following is correct? This statement is:

a) true, because the US is one of the richest countries in the world

b) true, because the resources that are scarce in the US can be imported from abroad

c) false, because not all the wants of all US citizens are fully satisfied

d) false, because a significant number of families in the US have incomes below what is known as the poverty level

3) 'The problem facing the government is whether to build a new motorway system or to improve public transport throughout the country during the next three years. Resources for both projects are not available. It must be one or the other.' Which of the following is correct? The opportunity cost of the new motorway system mentioned in the preceding paragraph is:

a) greater than the economy can afford

b) an improved public transport system

c) the money required to pay for it

d) the resources required to build it.

4) Which of the following is correct? A production possibility frontier illustrates that:

a) an economy's capacity to produce increases in proportion with population

b) if all the resources of an economy are employed efficiently, more of one good can be produced only if less of another good is produced

c) an economy automatically adjusts to that level of output at which all of its resources are employed efficiently

d) various combinations of output can maximise the welfare of society.

5) Saving is a leakage from the flow of income in the economy because;

a) it is typically a lower proportion of income than consumption spending

b) it is never channelled into useful spending

c) it is that part of income that is not currently spent

d) it is usually greater than investment spending

6) Which of the following is correct? The consumption function shows:

a) that consumption depends primarily on the level of business investment

b) that households consume more when interest rates are low

c) that the marginal propensity to consume increases with national income

d) the amounts households plan to consume at various possible levels of income

7) Aggregate demand will increase if;

a) consumption falls

b) investment falls

c) exports fall

d) imports fall

8) In the national accounts, the difference between gross investment and net investment is;

a) Imports

b) capital flight

c) income earned by foreigners

d) depreciation

9) As disposable income increases, consumption expenditure

a) increase by the same amount

b) increase by a smaller amount

c) increase by a larger amount

d) remain constant

10) If the consumption function is C= 20 + 0.5Y, then an increase in disposable income of 100, will result in an increase in consumption expenditure by;

a) 25

b) 50

c) 70

d) 80

11) To see whether a firm is making an economic profit, which of the following should be deducted from its revenue?

a) Its explicit costs only

b) Its explicit costs plus depreciation

c) Its implicit costs only

d) Its explicit costs and its implicit costs

12) In the short-run, which of the following always gets smaller as output increases?

a) Average fixed cost

b) Average variable cost

c) Short-run average cost

d) Short-run marginal cost

13) Which of the following is the correct definition of the law of diminishing returns?

a) If extra units of one variable input are added to a fixed amount of all other inputs, then sooner or later the marginal returns will get smaller

b) If extra units of one variable input are added to a fixed amount of all other inputs, then the marginal returns will always get smaller

c) If extra units of all variable inputs are added to a fixed amount of all fixed inputs, then the marginal returns will always get smaller

d) If extra units of all variable inputs are added to a fixed amount of all fixed inputs, then sooner or later the marginal returns will get smaller

14) A profit-maximizing monopolist sets an output of 100 per day and a price of K10. Which of the following statements is true?

a) The firm's *SMC* and *MR* curves intersect at an output of 100, and the point on its demand curve at this output is at K10

b) The firm's *SMC* and *MR* curves intersect at an output of 100, and the point on its *MR* curve at this output is at K10

c) The firm's *SMC* and *AR* curves intersect at an output of 100, and the point on its *MR* curve at this output is at K10

d) The firm's *SMC* and *AR* curves intersect at an output of 100, and the point on its *AR* curve at this output is at K10

15) The notion that countries stand to gain more if they trade in the commodity of their lowest opportunity cost is referred to as;

a) International trade.

b) Comparative advantage.

c) Absolute advantage.

d) Equal advantage.

16) If the kwacha appreciates against other currencies in the exchange rate market, this will;

a) Have no effect on the Zambian current account.

b) Worsen the Zambian current account.

c) Improve the Zambian current account.

d) Have an effect depending on the other currencies in the market.

17) The terms of trade measure;

a) the income of one country compared to another.

b) the quantity of exports of one country compared to another.

c) export prices relative to import prices.

d) the difference between the value of exports and that of imports.

18) If people are made unemployed because of a fall in aggregate demand, this is known as.

a) Frictional unemployment

b) Seasonal unemployment

c) Cyclical unemployment

d) Structural unemployment

19) The labour force is made up of;

a) the number of people employed minus the number of people unemployed

b) the number of people employed plus the number of people unemployed

c) the number of people employed only

d) the whole population in a country

20) Demand management policy measures tend to affect

a) Output and level of employment in opposite directions

b) Output and the price level in opposite directions

c) The level of employment and the price level in opposite directions

d) The price level and the level of unemployment in opposite directions

21) An increase in deficit spending by the government that is financed by domestic borrowing would most likely

a) increase aggregate demand, but at the expense of lower investment spending

b) decrease aggregate demand, but stimulate investment spending

c) increase aggregate demand, and stimulate investment spending

d) decrease aggregate demand, as well as investment spending

22) In game theory, a dominant strategy is

a) strategy that yields optimal results no matter what the rival firm does.

b) a special case of a Nash equilibrium.

c) one that delivers the maximum profits for one player and reduced profits for all rivals.

d) Both 1 and 2.

23) In economic theory, equilibrium in dominant strategies occurs when
a) one firm has a dominant strategy that the others must follow, and the outcome for each firm is the best possible given the dominant firm's position.
b) one firm has a dominant strategy that the others must follow, and so only one set of payoffs is possible.
c) every firm has a dominant strategy, and the outcome for each firm depends upon their rival firms implementing their dominant strategy.
d) every firm has a dominant strategy, and the outcome for each firm is the best regardless of what rival firms are doing.

24) Which of the following market structures features free entry and exit?
(i) perfect competition
(ii) monopolistic competition
(iii) monopoly
a) (i) only
b) (i) and (ii) only
c) (ii) and (iii) only
d) All of the above are correct.

25) Product differentiation causes the seller of a good to face what type of demand curve?
a) downward sloping
b) upward sloping
c) horizontal
d) vertical

26) A special kind of imperfectly competitive market that has only two firms is called
a) a two-tier competitive structure.
b) an incidental monopoly.
c) a doublet.
d) a duopoly.

27) When firms have agreements among themselves on the quantity to produce and the price at which to sell output, we refer to their form of organization as a

a) Nash arrangement.
b) cartel.
c) monopolistically competitive oligopoly.
d) perfectly competitive oligopoly.

28) An agreement among firms over production and price is called
a) an antitrust market.
b) a trade arrangement.
c) collusion.
d) a Nash conspiracy.

29) One way in which monopolistic competition differs from oligopoly is
a) there are no barriers to entry in oligopolies.
b) in oligopoly markets there are only a few sellers.
c) all oligopoly firms eventually earn zero economic profits.
d) strategic interactions between firms are rarely evident in oligopolies.

30) In economic theory, the firm's optimal strategy is

a) a rule or plan of action for playing the game that maximizes the expected payoff.
b) one that delivers the maximum profits for all players involved.
c) a rule of thumb that minimizes the need to analyse all possible rival moves.
d) Both 1 and 2.

Question 31

a) Suppose you have just been shortlisted for interviews to be employed as manager for Zambia State Insurance Corporation (ZSIC), and have been informed that the price elasticity of demand for their insurance products is less than 1. During your consultations with your colleagues in preparation for the interview, you discover that there is need to increase the revenues for ZSIC once given the job. To increase total revenues, what should you do? Explain fully with the aid of a diagram(s).[2 marks]
b) Nathan's utility function can be described as $U(w) = \sqrt{w}$. He faces a potential loss of K100, 000 in the event that her house burn down, which has a probability of 0.01. Calculate the maximum premium that Nathan would be prepared to pay to insure himself against the total loss of his house if his initial level of wealth was K140, 000 and comment on your results.[2 marks]
c) Suppose that Zambia State Insurance Corporation (ZSIC) has an initial wealth of K100 million and a utility function of the form $U(w) = w$. Find the minimum premium ZSIC would require in order to offer insurance to Nathan and comment on whether insurance is feasible in this instance.[2 marks]

Question 32

a) With the aid of a well labelled diagram, explain what will happen in a market for Insurance if government fixes a minimum price for insurance products above the equilibrium price [2 marks]
b) A bank's liquidity ratio is 10 per cent, and the bank's deposits increase by K30 million.
   i. Calculate the increase in total deposits [1 mark]
   ii. Explain the circumstances in which overall multiplier effect could be smaller than that shown by your result in (i) above. [2 marks]

Question 33

i. Describe two reasons for firms experiencing "economies of scale" [2 marks]
ii. Describe two reasons for firms experiencing "diseconomies of scale" [2 marks]

Question 34

The Zambian Kwacha has been depreciating of late and this has led to discontent among some sections of the society. Some observers have called on government to "control" the exchange rate market but others have argued that this may hurt the economy further if not well handled.

i. List any three(3) advantages of having a free-floating exchange rate [3 marks]
ii. List any three(3) disadvantages of having a free-floating exchange rate [3 marks]

Question 35

i. With the aid of a diagram were necessary, explain two (2) main aims of advertising [3 marks]
ii. List any three (3) advantages of advertising [3 marks]

Question 36

With the aid of a diagram were necessary, explain the following;

a) Loss making monopolist [3 marks]
b) Second- degree price discrimination [3 marks]
c) The product life cycle [3 marks]

Question 37

a) Provide any four (4) arguments in favour of restricting trade [4 marks]
b) With the aid of a diagram, explain the welfare effects of a tariff [4 marks]
c) List any four (4) arguments against trade restriction [4 marks]

Question 38

a) Explain the three (3) functions of money [3 marks]
b) List any three (3) functions of the central bank [3 marks]
c) Describe the three (3) motives for holding money [3 marks]

Question 39

With the aid of a well labelled diagram, briefly explain the following;

a) Full employment and no inflation [3 marks]
b) A recessionary (or deflationary) gap [3 marks]
c) An inflationary gap [3 marks]

Question 40

With the aid of a diagram(s), explain the following;

a) How the fall in the price of Bread affects the demand for Butter [2 marks]
b) How the increase in the price of Fruit Tree affects the demand for Pure Joy [2 marks]

END OF FINAL EXAMINATION

The University of Zambia

School of Natural Sciences

Department of Mathematics & Statistics

Mid-Year Examinations - March 2016

MAT5111 - Ordinary Differential Equations & Integral Equations

Time allowed : 3hrs

Instructions:
- Attempt **all five (5)** questions. All questions carry equal marks.
- **Full credit** will only be given when **necessary work** is shown.
- Indicate your **computer number** on all answer booklets.

*This paper consists of **3** pages of questions.*

---

1. a) Given an initial value problem

$$y'(t) = f(t, y(t)) , \qquad a \leq t \leq b , \qquad y(a) = \alpha ,$$

define the following :-

i) a Lipschitz condition.

ii) a well-posed problem

iii) a non-autonomous differential equation

b) Let A be a real $n \times n$ matrix and consider the equation $x' = Ax$. Show that the function

i) $t \mapsto e^{\lambda t}v$ is a real solution if and only if $\lambda \in \mathbb{R}$, $v \in \mathbb{R}^n$ and $Av = \lambda v$.

ii) If $v \neq 0$ is an eigenvector for A with eigenvalue $\lambda = \alpha + i\beta$ such that $\beta \neq 0$, then the imaginary part of ν is not zero and that if $\nu = u + iw \in \mathbb{C}^n$, then there are two real solutions

$$t \to e^{\alpha t}[(\cos \beta t)u - (\sin \beta t)w]$$

$$t \to e^{\alpha t}[(\sin \beta t)u + (\cos \beta t)w]$$

iii) Show that the solutions in (ii) are linearly independent.

c) Given the initial value problem

$$y'(t) = 1 + t\sin(ty)\ , \qquad 0 \leq t \leq 2\ , \qquad y(0) = 0\ ,$$

show that a unique solution exists to the above initial value problem.

2. a) Given a linear system $x'(t) = A(t)x(t)$, define the following :-

i) a fundamental set of solutions.

ii) a fundamental matrix solution.

iii) a resolvent matrix

b) Let ϕ and ψ be two fundamental matrix solutions to the linear system $x' = A(t)x(t)$ (where $A \in M_n(\mathbb{K})$). Show that there exists a constant non-singular matrix $C \in M_n(\mathbb{K})$ such that $\psi(t) = \phi(t)C$ for all $t \in I$.

c) Show that the resolvent matrix satisfies the identity

$$\frac{\partial}{\partial s} R(t,s) = -R(t,s)A(s)\ .$$

3. a) i) Define the exponential of a matrix e^M, where M is an $n \times n$ matrix.

ii) Show that a solution matrix Φ of $y' = Ay$ on an interval I is a fundamental matrix of $y' = Ay$ on I if and only if $\det \Phi(t) \neq 0$ for every t on I.

b) Show that a fundamental matrix of the system $y' = Ay$ when A is a diagonal matrix

$$A = \begin{pmatrix} d_1 & & 0 \\ & d_2 & \\ & & \ddots \\ 0 & & d_n \end{pmatrix}$$

is

$$\begin{pmatrix} \exp(d_1 t) & & & 0 \\ & \exp(d_2 t) & & \\ & & \ddots & \\ 0 & & & \exp(d_n t) \end{pmatrix}$$

c) Find a fundamental matrix of the system $\mathbf{y}' = A\mathbf{y}$ if

$$A = \begin{pmatrix} -2 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -2 \end{pmatrix}$$

4. a) A mathematical model of a physical process should have the following three properties: existence, uniqueness and continuity. Discuss each of the three properties in the context of a mathematical model.

   b) i) Express the equation $y'' + k_1 y' + k_2 \sin y = 0$ in the form $\mathbf{y}' = \mathbf{f}(t, \mathbf{y})$.

   ii) Discuss the problem of existence and uniqueness of solution for the system in (i).

   c) Discuss the problem of existence and uniqueness of solutions of the IVP for the system

$$\begin{aligned} y_1' &= y_2 + ty_3 \\ y_2' &= (\sin t)y_1 + t^2 y_3 \\ y_3' &= y_1 - ty_2 \end{aligned}$$

5. a) State Gronwall's inequality.

   b) Let ϕ and ψ be two solutions of the initial value problem, $x' = f(t,x)$, $x(t_0) = x_0$, $|t - t_0| \leq \alpha$. Use Gronwall's inequality to show that $\phi = \psi$.

   c) Solve the renewal equation when $\rho(t) = te^{-t}$.

6. a) Consider the Volterra equation of the second kind

$$f(t) = g(t) + \int_0^t K(t, s, f(s))ds, \qquad 0 \leq t \leq T \ .$$

   i) Show that a second-order differential equation $y'' = f(x, y)$ can be written in this form.

   ii) Consider the linear V2 equation. If the kernel is of the form

$$k(t,s) = -\sum_{i=0}^{n} P_i(t)Q_i(s)$$

   show that the equation has a solution

$$f(t) = g(t) - \sum_{i=0}^{n} P_i(t)y_i(t)$$

   where the functions $y_i(t)$ satisfy an initial-value ODE system.

   b) Given $K(t,s)$ is continuous on $0 \leq s \leq t \leq T$ and $g(t)$ is continuous in $0 \leq t \leq T$, show that the linear Volterra equation of the second kind has a unique continuous solution in $0 \leq t \leq T$.

END!

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF MATHEMATICS & STATISTICS

2015 ACADEMIC YEAR MIDYEAR EXAMINATIONS

29thFEB 2016

MAT 5331 - FUNCTIONAL ANALYSIS

INSTRUCTIONS:

1. There are five (5) questions in this paper. You are required to **answer a total of four (4) questions.**
2. Section A consists of a compulsory question. Answer any three (3) questions from Section B. All questions in section B carry equal marks.

TIME ALLOWED: Three (3) hours

[TURN OVER]

SECTION A

1. (a) Define the following:

   (i) a metric space X. [1]

   (ii) a normed space X. [1]

   (iii) an inner product space. [1]

   (iv) a Banach space X. [1]

   (v) a Hilbert space H. [1]

   (vi) a bounded linear transformation from a normed linear space X to Y a normed linear space. [1]

   (b) Let X be a linear space, define the following:

   (i) a bounded linear functional on X. [1]

   (ii) a segment joining two elements x and y in X. [1]

   (iii) a convex subset M of X. [1]

   (iv) the orthogonal complement of M in X. [1]

   (v) orthonormal basis of $M \subset X$. [1]

   (vi) a direct sum $X = Y \oplus Z$ where Y and Z are subspaces of X. [1]

   (c) Let H_1 and H_2 be Hilbert spaces, $T : H_1 \to H_2$ a bounded linear operator, $\mathcal{D}(T)$ be the domain of T. Define the following:

   (i) restriction of an operator T to a subset $B \subset \mathcal{D}(T)$. [1]

   (ii) extension of an operator T to a subset $D \supset \mathcal{D}(T)$. [1]

   (iii) adjoint operator T^* of T. [1]

   (iv) self adjoint operator [1]

   (v) unitary operator, [1]

   (vi) normal operator. [1]

   (d) State the following (without proof)

   (i) Hahn-Banach theorem. [1]

   (ii) Riesz representation theorem. [1]

[TURN OVER]

SECTION B

2. (a) Let X be a normed linear space. Show that the norm on X induces a metric on X. [5]

   (b) Let X be a normed linear space. Show that for $x \in X$, the norm function defined by $x \mapsto \|x\|$ is a continous mapping i.e., ($x_n \to x$ in X implies $\|x_n\| \to \|x\|$). [5]

   (c) Show that in an inner product space, if $x_n \to x$ and $y_n \to y$, then $\langle x_n, y_n \rangle \to \langle x, y \rangle$. [5]

   (d) Show that the space $\mathbb{Q}$ of rational numbers with the usual metric given by $d(x, y) = |x - y|$ for $x, y \in \mathbb{Q}$ is not complete. [5]

3. (a) Show that the dual space X' of a normed linear space X is a Banach Space. [5]

   (b) Let X be a linear space and K a scalar field. Let $f : X \to K$ be a linear functional. Show that f is continous if and only if it is bounded. [5]

   (c) Consider a functional on $\mathbb{R}^3$ defined as follows: $f_x = x_1 + x_2 - x_3$ where $x = (x_1, x_2, x_3)$. Find the null space of f. [5]

   (d) Show that the dual space of l^1 is l^∞. [5]

4. (a) Show that an inner product on a space X induces a norm on X as well as a metric on X. i.e., (inner product spaces are normed spaces and in particular Hilbert spaces are Banach spaces). [5]

   (b) For any inner product space X. Show that there exists a Hilbert space H and an isomorphism from X onto a dense subspace $W \subset H$. [5]

   (c) Let M be a non empty subspace of a Hilbert space H. Prove that the span of M is dense in H if $M^\perp = \{0\}$. [5]

   (d) Let (e_k) be an orthonormal basis in l^2. Give an example of $x \in l_2$ such that $\sum |\langle x, e_k \rangle|^2 = \|x\|$. [5]

[TURN OVER]

5. (a) Let f be a bounded linear functional on a Hilbert space H. Show that f can be uniquely represented as $f(x) = \langle x, z \rangle$ where z depends on f. [5]

(b) Prove that if T is self adjoint then it is normal. Show by the use of an example that a normal operator need not be self adjoint. [5]

(c) Let $T : H \to H$ be a bounded linear operator on a Hilbert space H. Prove the following:

(i) if $T = T^*$, then $\langle Tx, x \rangle$ is real for all $x \in H$.

(ii) if H is complex and $\langle Tx, x \rangle$ is real for all $x \in H$, then $T = T^*$. [5]

(d) Show that for any bounded linear operator T on a Hilbert space H, the operators $T_1 = \frac{1}{2}(T + T^*)$ and $T_2 = \frac{1}{2i}(T - T^*)$ are self adjoint. [5]

■ END OF EXAMINATION ■

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

2015 ACADEMIC YEAR FINAL EXAMINATIONS

MAT5611 : STATISTICAL INFERENCE

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: 1. Answer any **Four** (4) Questions
2. Show All Essential Working

---

1. (a) Define the following:
   (i) complete statistic T.
   (ii) location equivariant estimator.

   (b) Let $X_1, X_2, \ldots, X_n$ be a random sample from a $GEO(\theta)$ distribution with probability function $f_\theta(x) = \theta(1-\theta)^{x-1}$, $x = 1, 2, \ldots; 0 < \theta < 1$. Given that $T = \sum_{i=1}^{n} X_i$,
   (i) find the distribution of $f(x_1, x_2, \ldots, x_n \mid T = t)$. What do you conclude about T?
   (ii) show that $T = \sum_{i=1}^{n} X_i$ is a complete statistic.
   (iii) find a UMVUE of $\tau(\theta) = \frac{1}{\theta}$.

   (c) Let $X_1, X_2, \ldots, X_n$ be a random sample from $f_\theta(x) = \frac{e^{-\theta}\theta^x}{x!}$, $x = 0, 1, 2, \ldots$
   (i) Find $E[(-1)^{X_1}]$.
   (ii) Find $P(X_1 = x | T = t)$ where $T = \sum_{i=1}^{n} X_i$.

2. (a) Let $X_1, X_2, \ldots, X_n$ and $Y_1, Y_2, \ldots, Y_m$ be independent random samples from independent normal distributions $N(\mu_1, \sigma_1^2)$ and $N(\mu_2, \sigma_2^2)$ respectively, where μ_1 and μ_2 are known constants.

(i) Show that the generalized likelihood ratio test for testing $H_0 : \sigma_1^2 = \sigma_2^2$ against $H_1 : \sigma_1^2 \neq \sigma_2^2$ is given by

$$\Lambda(x, y) = \left[\frac{n}{n+m}\left(1+\frac{1}{u}\right)\right]^{\frac{n}{2}}\left[\frac{m}{n+m}(u+1)\right]^{\frac{m}{2}}$$

where $u = \dfrac{\sum_{i=1}^{n}(x_i - \mu_1)^2}{\sum_{j=1}^{m}(y_j - \mu_2)^2}$

(ii) Find the distribution of $V = \dfrac{\frac{1}{n}\sum_{i=1}^{n}(X_i - \mu_1)^2}{\frac{1}{m}\sum_{j=1}^{m}(Y_j - \mu_2)^2}$ under H_0.

(b) Let $X_1, X_2, \ldots, X_n$ be a random sample from a distribution with probability density function $f(x) = \dfrac{\alpha x^{\alpha-1}}{\beta^{\alpha}}$, $0 < x < \beta$.

(i) Find a sufficient statistic for $\theta = (\alpha, \beta)$.

(ii) Show that the statistic in (i) is a minimal sufficient statistic.

3. (a) (i) State the information inequality.

(ii) Prove the information inequality.

(b) Let $X_1, X_2, \ldots, X_n$ be a random sample from

$$f(x) = \left(\frac{\lambda}{2\pi x^3}\right)^{\frac{1}{2}} e^{\left(-\frac{\lambda x}{2\mu^2} + \frac{\lambda}{\mu} - \frac{\lambda}{2x}\right)}, \quad x > 0; \quad \lambda > 0, \mu > 0$$

Find the

(i) maximum likelihood estimator for $\theta = (\lambda, \mu)$.

(ii) information function of X.

(iii) Fisher information function.

4. (a) (i) State Basu's theorem.

(ii) Prove Basu's theorem.

(b) Let $X_1, X_2, \ldots, X_n$ be a random sample from the distribution with p.d.f..

$f_\theta(x) = \dfrac{1}{\theta} e^{-\frac{1}{\theta}(x-10)}$, $x > 10$; $\theta > 0$. Find

(i) the maximum likelihood estimator of θ.

(ii) an approximate 95% confidence interval for θ.

(c) Let $X_1, X_2, \ldots, X_n$ be a random sample from the distribution with $E\left(\frac{1}{X_i}\right) = 4\theta$ and $Var\left(\frac{1}{X_i}\right) = 4\theta^2$, $i = 1, 2, \ldots, n$. Consider the estimating function $\psi(\theta, X) = \sum_{i=1}^{n}\left(\frac{1-4\theta X_i}{\theta^2 X_i}\right)$, $\theta > 0$.

(i) Show that $\psi(\theta, X)$ is an unbiased estimating function.

(ii) Find an estimator $\hat{\theta}$ that satisfies $\psi(\hat{\theta}, X) = 0$.

5. (a) Define the following:

(i) locally most powerful test.

(ii) an unbiased estimating function.

(b) Let $X_1, X_2, \ldots, X_n$ be a random sample from $f_\theta(x) = e^{-(x-\theta)}$, $x > \theta$.

(i) Show that $f_\theta(x)$ is a location invariant family distribution.

(ii) Show that $T = X_{(1)}$ is a complete sufficient statistic for θ.

(iii) Show that $X_{(1)}$ and $\sum_{i=1}^{n}(X_i - X_{(1)})$ are independent.

(c) Suppose $X_1, X_2, \ldots, X_n$ is a random sample from an exponential distribution with mean $\frac{1}{\theta}$, $f_\theta(x) = \theta e^{-\theta x}$, $x > 0$ and assume that the prior density of θ is also exponential with mean $\frac{1}{\beta}$, where β is known.

(i) Show that the posterior distribution is $\theta \mid x \sim GAM\left(n+1, \frac{1}{\beta + \sum_{i=1}^{n} x_i}\right)$

(ii) Find the Bayes estimator of θ, using the squared error loss function.

(iii) Find the Bayes estimator of $\mu = \frac{1}{\theta}$, using the squared error loss function.

(Hint: If $X \sim GAM(\alpha, \beta)$ then $f(x) = \frac{x^{\alpha-1}}{\beta^\alpha \Gamma(\alpha)} e^{-\frac{x}{\beta}}$, $x > 0$; $\alpha > 0$, $\beta > 0$)

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