THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

SECOND SEMESTER EXAMINATIONS 2009

1.	BIO 1022	MOLECULAR BIOLOGY AND GENETICS
2.	BIO 2032	BASIC MICROBIOLOGY
3.	BIO 2062	DIVERSITY OF ANIMALS
4.	BIO 2085	INTRODUCTION TO BIOSTATISTICS
5.	BS 319	BIOSTATISTICS
6.	BS 321	ETHOLOGY AND EVALUATION
7.	BS 322	ECOLOGY
8.	BS 332	ANIMAL PHYSIOLOGY
9.	BS 343	MYCOLOGY
10.	BS 362	GENETICS
11.	BS 412	APPLIED ENTOMOLOGY
12.	BS 432	ADVANCED PARASITOLOGY 2
13.	BS 445	ECOPHYSIOLOGY OF PLANTS
14.	BS 455	WILDLIFE ECOLOGY
15.	BS 492	FISHERIES BIOLOGY
16.	BS 925	BIOLOGY OF TERRESTRIAL VERTEBRATES
17.	C 102	INTRODUCTORY TO CHEMISTRY 2
18.	C 212	INTRODUCTION TO BIOCHEMISTRY
19.	C 225	ANALYTICAL CHEMISTRY 1
20.	C 312	BIOCHEMISTRY 2
21.	C 322	ANALYTICAL CHEMISTRY 3
22.	C 342	INORGANIC CHEMISTRY 3
23.	C 352	ORGANIC CHEMISTRY 4
24.	C 362	COLLOIDS AND ELECTROCHEMISTRY
25.	C 412	ADVANCED BIOCHEMISTRY 2
26.	C 452	ADVANCED ORGANIC CHEMISTRY
27.	C 482	INORGANIC INDUSTRIAL CHEMISTRY
28.	CS 2032	COMPUTER ARCHITECTURE
29.	CS 3252	ELECTRNICS FOR COMPUTING
30.	CST 2012	PROGRAMMING IN JAVA 2
31.	CST 3032	ARTIFICIAL INTELLECTUAL

32.	CST 3142	SOFTWARE ENGINEERING 2
33.	CST 4012	ADVANCED OPERATING SYSTEMS AND DISTRIBUTED SYSTEMS
34.	CST 4122	FUNDAMENTALS OF COMPILER
35.	CST 4132	COMPUTER GRAPHICS
36.	GEO 112	INTRODUCTION TO HUMAN GEOGRAPHY 2
37.	GEO 175	INTRODUCTION TO MAPPING TECHNIQUES IN GEOGRAPHY (PAPER 1- PRACTICAL)
38.	GEO 212	GEOGRAPHY OF ZAMBIA
39.	GEO 212	THE GEOGRAPHY OF ZAMBIA
40.	GEO 272	QUANTITATIVE TECHNIQUES IN GEOGRAPHY 2(FORMULAS)
41.	GEO 272	QUANTITATIVE TECHNIQUES IN GEOGRAPHY 2
42.	GEO 492	NATURAL RESOURCE ECONOMICS
43.	GEO 912	GEOGRAPHY OF MIGRATION AND REFUGEES
44.	GEO 922	GEOGRAPHY OF REGIONAL PLANNING AND DEVELOPMENT
45.	GEO 932	URBAN GEOGRAPHY
46.	GEO 952	GEOGRAPHICAL HYDROLOGY
47.	GEO 955	GEOMORPHOLOGY
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49.	GEO 975	CARTOGRAPHY
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51.	M 112	MATHEEMATICAL METHODS 2-A
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71. P 455 QUANTUM MECHANICS 2

THE UNIVERSITY OF ZAMBIA
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2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BIO 1022: MOLECULAR BIOLOGY AND GENETICS
THEORY PAPER
TIME: THREE HOURS

Instructions:

1. Answer **all** questions (choose the best answer from the options)
2. Use ink to record the answers on the mark sheet provided
3. A correct answer carries +4 marks
4. A wrong answer carries –1 mark
5. The option "I do not know" carries 0 mark
6. Cross out a wrong entry and write the correct one by the side
7. Hand in both the answer sheet and question paper at the end of the examination

1. Prokaryotic chromosomes …
   1. are enclosed in a nuclear envelope.
   2. are made up of DNA as well.
   3. include histones in their structures.
   4. consist of a circular DNA molecule
   5. consist of a linear DNA molecules.
   6. I do not know.

2. A chromatid is …
   1. a non staining part of a chromosome.
   2. a dense substance in a nucleus of a non dividing cell
   3. one of two identical parts of a chromosome
   4. a point at which each pair of chromatids are joined.
   5. the same as a centromere.
   6. I do not know

3. Every species has …
   1. diploid gametes.
   2. a unique number of chromosomes per cell.
   3. at least eight chromosomes per cell.
   4. a number of chromosomes that varies with the complexity of the organism.
   5. only one set of chromosomes whose number changes with age.
   6. I do not know.

4. Mitosis …
   1. can increase the number of body cells without changing the information contained in the DNA of the cells
   2. is a means of reproducing sexually.
   3. is not dependent on cell size.
   4. results in cells that are genetically different from the parent cell.
   5. is different in animal and plant cells during karyokinesis.
   6. I do not know

5. Interphase …
   1. is composed of G1, G2 and G3 only.
   2. is the time interval between meiosis I and meiosis II.
   3. takes a shorter period of time in the life cycle of a cell.
   4. is a time of cell growth and duplication of cellular components
   5. is the division of a cell.
   6. I do not know.

6. Cytokinesis …
   1. differs in animal and plant cells.
   2. does not occur in plant cells.
   3. immediately precedes mitosis.
   4. is a process of nuclear division.
   5. is a process in which cells synthesise DNA.
   6. I do not know.

7. Crossing over of chromosomes occurs during …
   1. mitosis.
   2. interphase.
   3. meiosis II.
   4. meiosis I.
   5. metaphase I
   6. I do not know.

8.

RNA	Function	Structural materials
(a) mRNA	Transfers genetic information from DNA	Guanine, Uracil and Cytosine.
(b) tRNA	Carries hereditary information from DNA	Thymine, Cytosine and Adenine.
(c) rRNA	Binds anticodon to mRNA codon	Uracil, Adenine and Guanine.

Which set of statements in the table above is correct?
   1. (a)
   2. (a) and (b)
   3. (a), (b) and (c)
   4. (b)
   5. (c)
   6. I do not know

9. A procedure used to detect an unknown genotype of an individual is called a …
   1. monohybrid cross.
   2. dihybrid cross.
   3. hybrid cross.
   4. test cross
   5. Punnett cross.
   6. I do not know.

10. In snakes the homozygote recessive genotype (cc) causes the animal to be an albino despite the inheritance of a dominant allele B for black. What would be the result of a cross between two snakes each with the following genotype; CcBB?
   1. All snakes will be black.
   2. All snakes will be albino
   3. 9:3:3:1 (black: brown: grey: albino respectively)
   4. 3:1 (Black: albino respectively)
   5. 1:2:1 (Black: Brown: Albino respectively)
   6. I do not know.

11. A cross between plants with oblong fruits and one with round squash fruits has produced oval squash fruits. This cross is an example of …
   1. complete dominance.
   2. epistatic gene.
   3. codominant gene.
   4. incomplete dominance.
   5. dihybrid gene
   6. I do not know

12. A gene is a ...
    1. segment of DNA. ✓
    2. chromosome.
    3. segment of RNA.
    4. protein. genotype
    5. lipid portion of DNA.
    6. I do not know.

13. Identify a heterozygous genotype parent in the following set of answers.
    1. pp
    2. YY
    3. Zz .
    4. yypp
    5. YYPP
    6. I do not know.

14. In a monohybrid cross between a homozygous dominant parent and a homozygous recessive parent, one would predict the offspring to be ...
    1. 3 homozygous dominant : 4 homozygous recessive.
    2. 2 heterozygous : 4 homozygous recessive.
    3. 1 heterozygous : 4 homozygous recessive.
    4. 1 homozygous recessive : 3 heterozygous ...
    5. all would be heterozygous.
    6. I do not know

15. Segregation of alleles occurs during ... of cell division.
    1. interphase.
    2. anaphase.
    3. telophase.
    4. pollination.
    5. fertilisation
    6. I do not know.

16. In a dihybrid cross between two heterozygous parents, the probability of obtaining an offspring that is homozygous recessive for both traits would be...
    1. 3/16
    2. 6/16
    3. 9/16
    4. 1/16.
    5. 8/16
    6. I do not know

17. Suppose that you had crossed a red flowering plant with a yellow flowering plant and all the offspring had orange flowers. You might assume that the alleles for flower colour show...
    1. codominance.
    2. incomplete dominance.
    3. are either dominant or recessive.
    4. some kind of mutation.
    5. are heterozygous dominant.
    6. I do not know.

18. According to …, each pair of factors is carried by a pair of homologous chromosomes, with each chromosome carrying one factor.
    1. Mendel's first law.
    2. Mendel's second law
    3. Fleming's law
    4. recombination of genes
    5. independent assortment
    6. I do not know

19. Which one of the following statements is correct?
    1. Information needed for making proteins is carried on DNA.
    2. DNA directs RNA to make lipids that are needed by a cell.
    3. DNA directs tRNA to make ribosomes.
    4. DNA directs RNA to produce glucose.
    5. RNA contains hereditary information to various enzymes.
    6. I do not know

20. The language of DNA is based on … molecules.
    1. sugar.
    2. nucleotide.
    3. phosphate.
    4. lipid.
    5. hydrogen bond
    6. I do not know

21. Covalent bonds are found …
    1. between purines and pyrimidines
    2. Guanine and cytosine.
    3. in the sugar phosphate back bones.
    4. between mRNA and DNA.
    5. between electropositive atoms and electronegative atoms of DNA.
    6. I do not know

22. Complementary base pairing is important for …
    1. DNA replication.
    2. RNA transcription.
    3. RNA translation.
    4. tRNA.
    5 all the statements above are correct.
    6. I do not know

23. The difference between DNA and mRNA is that mRNA ...
    1. is a polymer made up of nucleotides.
    2. contains Adenine.
    3. contains a sugar called ribose.
    4. contains diester bonds.
    5. contains phosphate groups
    6. I do not know

24. Codons are …
    1. made up of two nucleotide sequences on mRNA.
    2. sequences of proteins on DNA.
    3. located on tRNA molecules.
    4. are made up of three nucleotide base sequences on mRNA.
    5. sequences of polypeptides on chromosomes.
    6. I do not know

25. The pattern of base pairing in DNA can be summarised as follows:
    1. Purines with purines
    2. Purines with pyrimidines
    3. Adenine with Guanine
    4. Adenine with Cytosine
    5. Cytosine with Guanine
    6. I do not know

26. During a translation process, the formation of peptide bonds occurs …
    1. in the nucleus.
    2. during the initiation stage of protein synthesis.
    3. during DNA replication.
    4. between amino acids during the elongation process.
    5. when a ribosome meets a termination codon.
    6. I do not know.

27. Transcription occurs …
    1. at ribosomes in all cells.
    2. in the cytosol of eukaryotes.
    3. in the nucleus of eukaryotes.
    4. in the nucleolus of eukaryotes.
    5. as a last step of protein synthesis.
    6. I do not know.

28. Transporting amino acids to ribosomes for assembly into proteins is the function of …
    1. DNA
    2. mRNA
    3. rRNA
    4. tRNA.
    5. aminoacyl synthetase
    6. I do not know

29. A repressor protein is coded for by a (an) …
    1. structural genes.
    2. regulator gene.
    3. promoter gene.
    4. operator.
    5. enhancer
    6. I do not know

30. Active DNA transcription in eukaryotes is carried out with the help of …
    1. an operon.
    2. mitochondria.
    3. an intron.
    4. plasma membranes.
    5. ribosomes.
    6. I do not know

31. When lactose is present in *E. coli*, it …
    1. stops transcription from occurring.
    2. acts as a regulator.
    3. binds to a repressor.
    4. binds to mRNA.
    5. acts as an inhibitor.
    6. I do not know

32. In eukaryotes, introns and exons are regions of … on mRNA
    1. proteins
    2. non-coding areas
    3. silent nucleotide base sequences
    4. immature gene(s).
    5. instructions for cell division
    6. I do not know

33. The control of gene expression in an operon enables organisms to …
    1. reproduce more quickly.
    2. avoid mutations from taking place in DNA.
    3. produce proteins only when needed.
    4. form new combinations of genes.
    5. provide maximum growth for a cell.
    6. I do not know

34. In eukaryotic cells, immature mRNA contains …
    1. introns only.
    2. exons only.
    3. both exons and introns.
    4. a pair of alleles.
    5. histones only.
    6. I do not know

35. A compound that contains amino acid sequences is …
    1. ATP.
    2. alcohol.
    3. protein.
    4. RNA.
    5. DNA.
    6. I do not know

36. During mitosis ...
    1. synapsis of chromosomes occurs.
    2. chromosomes align themselves at the equatorial plate during metaphase.
    3. duplication of DNA occurs.
    4. a new cell wall forms in the centre of animal cells.
    5. four daughter cells are formed.
    6. I do not know.

37. If a cell has 16 chromosomes before cell division, how many chromosomes will each of the four daughter cells have at the end of cell division?
    1. 16
    2. 8.
    3. 4
    4. 32
    5. 2
    6. I do not know.

38. Which of the following is (are) an example of a phenotype in organisms?
    1. production of high levels of amylase.
    2. the colour of fruits.
    3. failure by an organism to produce insulin.
    4. production of low concentrations of haemoglobin.
    5. all of the above.
    6. I do not know.

39. When alleles drift away from each other during cell division, this is a sign that ...
    1. independent assortment is taking place.
    2. mutation has taken place.
    3. the involved alleles are dominant.
    4. alleles are undergoing segregation.
    5. linkage is about to occur between genes.
    6. I do not know

40. Crossing over ...
    1. enables the second division of meiosis to occur.
    2. causes the number of chromosomes in a cell to be reduced by half.
    3. produces variation in the chromosomes.
    4. does not affect the inheritance of traits.
    5. is responsible for a high number of females in a community.
    6. I do not know.

41. If a segment of a DNA strand has the following base sequence; CGTAGC, the complementary strand of mRNA would be ...
    1. GCAUCG.
    2. CGUAGC
    3. ATGCAT
    4. AUGCAU
    5. GCATCG
    6. I do not know.

42. The genetic code facilitates for …
    1. duplication of DNA.
    2. RNA synthesis.
    3. construction of DNA
    4. specifying the type of amino acids in proteins.
    5. cell division.
    6. I do not know.

43. Which molecule is broken down to its monomer units after translation?
    1. DNA
    2. tRNA
    3. rRNA
    4. Amino acids
    5. mRNA.
    6. I do not know.

44. The two types of cell division enable genetic material to be…
    1. preserved.
    2. modified.
    3. replicated.
    4. mutation free.
    5. all the above are correct.
    6. I do not know.

45. During protein synthesis, the first anticodon on tRNA pairs with …
    1. tryptophan.
    2. glycine.
    3. methionine.
    4. leucine
    5. cysteine
    6. I do not know.

46. Which statement about the daughter cells of mitosis is correct?
    1. They differ from one another genetically.
    2. They differ genetically from the parent cell.
    3. They resemble each other and the parent cell. ✓
    4. They are normally smaller in size than the parent cell.
    5. They are normally larger than the parent cell.
    6. I do not know

47. Mitosis is similar to which process?
    1. Meiosis I
    2. Meiosis II. ✓
    3. interphase.
    4. G1 of meiosis II
    5. S phase of Meiosis I
    6. I do not know.

48. What is meant by the term 'homologous' chromosome?
    1. It is a pair of identical chromatids
    2. Chromosomes that have undergone recombination.
    3. It is a pair of identical chromosomes. ✓
    4. Chromosomes whose centromere will duplicate at metaphase.
    5. A pair of chromosomes that carry un-identical alles.
    6. I do not know.

49. During synapsis …
    1. chromatids from the same chromosome overlap.
    2. chromatids from different chromosomes exchange segments of DNA.
    3. Chromosomes from male and female gametes lie side by side during meiosis.
    4. Chromatids from different chromosomes separate from each other.
    5. All chromatids lie apart from each other.
    6. I do not know.

50. What is referred to as a tetrad during meiosis?
    1. A group of four chromosomes that 'touch' each.
    2. A group of four centromeres produced when two centromeres divide.
    3. When two spindle fibres duplicate.
    4. A group of four chromatids produced when two homologous chromosomes synapse.
    5. A group of four genetically identical daughter cells produced by mitosis.
    6. I do not know.

51. A die has six sides with numbers 1 to 6 marked on its sides. What is the probability of having an odd number face up when the die is thrown to the ground?
    1. 0.6
    2. 0.5.
    3. 0.4
    4. 0.3
    5. 0.2
    6. I do not know.

52. The ratios between dominant phenotypes and recessive phenotypes would not have held true if Mendel used … in his experiments.
    1. plants other than pea plants
    2. large numbers of plants
    3. small numbers of plants.
    4. animals
    5. maize plants
    6. I do not know

53. Predict the parental genotypes whose mating produces the following offspring genotypes: I^{AB}; I^{BO}; I^{AO} and I^{OO}

    1. I^{BA}; I^{BO}
    2. I^{AB}; I^{AO}
    3. I^{AO}; I^{BB}
    4. I^{AA}; I^{BO}
    5. I^{AO}; I^{BO}
    6. I do not know

54. A typical Mendelian monohybrid cross produces a phenotype ratio of 3:1. However, a monohybrid cross between two heterozygous white mice produced the following results; 234 all white mice. These results suggest …
    1. codominance.
    2. epistatic dominance.
    3. incomplete dominance
    4. presence of a lethal gene.
    5. a normal monohybrid cross
    6. I do not know

55. Two heterozygotes for a particular condition produce offspring in the expected phenotypic ratio of 1:2:1. State the sort of inheritance this ratio shows.
    1. Codominance
    2. epistatic dominance
    3. incomplete dominance.
    4. a cross involving multiple alleles.
    5. involvement of a lethal gene
    6. I do not know.

56. Which of the following statements is **true**?
    1. Heterozygous is a condition in which two alleles are identical.
    2. Gamete is a condition in which a cell has a diploid number of chromosomes.
    3. Dominant is a condition in which an allele fails to express itself.
    4. Height of humans is an example of a polygenic trait.
    5. Pleiotropy is also an example of a polygenic trait.
    6. I do not know.

57. 5' …ATCGGACTTCG… 3' sense strand of DNA
    3' …TAGCCTGAAGC… 5' antisense strand of DNA } Double helix
    State the transcription base sequence of mRNA arising from the DNA helix above.
    1. 5' …AUCGGACUUCG… 3'
    2. 5' …TAGCCTGAAGC… 3'
    3. 3' …AUCGGACUUCG… 5'
    4. 3' …TAGCCTGAAGC… 5'
    5. 5' …ATCGGACTTCG… 3'
    6. I do not know.

58. Identify a termination codon from the following:
    1. UUU
    2. UGU
    3. AUA
    4. UAG
    5. CAA
    6. I do not know.

59. Identify the amino acid(s) with a non degenerate codon(s).
Leucine (CUA, CUG, CUU, CUC
Arginine (AAA, AAG)
Methionine (AUG)

1. Leucine
2. Leucine and Arginine
3. Arginine and Methionine
4. Arginine
5. Methionine
6. I do not know.

60. Identify the mutation that is correctly represented.

1.	ACGATTACG ⇨	ACTTACG	insertion
2.	TTUCGATAA ⇨	TTUUGATAA	substitution
3.	GGACTACGG ⇨	GGACCTACGG	deletion
4.	AATAGACCG ⇨	AATAGACCG	insertion
5.	CCAATTGCA ⇨	CCAATTGCA	substitution

6. I do not know.

61. During which phase of cell division does the nuclear envelope disintegrate?
1. At the time of spindle fibre formation
2. During interphase
3. During anaphase
4. During telophase
5. At the time of duplication of centromeres
6. I do not know.

62. A triple bond is found between the base pairs of ...
1. Adenine and Thymine
2. Cytosine and Thymine
3. Guanine and Adenine
4. Thymine and Guanine
5. Guanine and Cytosine
6. I do not know.

63. The enzyme involved in the synthesis of mRNA is ...
1. called ATPase
2. a Polymerase
3. an amylase
4. called glucosidase
5. a glycosidase
6. I do not know.

64. Incoming tRNA is attached to …
    1. The peptidyl compartment
    2. mRNA
    3. rRNA
    4. a chromosome primer
    5. The aminoacyl compartment
    6. I do not know.

65. The probability of a sperm getting an allele for black hair from a heterozygous black guinea pig is …
    1. 0.25
    2. 0.50
    3. 1.0
    4. 0.75
    5. 0.0
    6. I do not know.

66. What is the probability that an offspring with the genotype (Yw) would be produced in a cross involving a plant with yellow flowers (Yy) and one with white flowers (Ww)?
    1. 0.25
    2. 0.025
    3. 75.0
    4. 50.0
    5. 0.50
    6. I do not know.

67. The results of a genetic cross gave the following genotype ratio; 1:1:1:1. This result signifies …
    1. mating of homozygous recessive parents.
    2. mating of homozygous dominant parents.
    3. mating of a homozygous dominant parent with a heterozygous one.
    4. a monohybrid back cross
    5. a dihybrid test cross
    6. I do not know.

68. How many chromosomes are on each side of the equatorial plate of a dividing cell at metaphase I of meiosis in a human cell?
    1. 23
    2. 46
    3. 96
    4. 192
    5. 384
    6. I do not know.

69. How many types of tRNAs are there in a cell for each amino acid?
    1. All types
    2. none
    3. Several
    4. Two
    5. One
    6. I do not know.

70. Mitosis is a kind of cell division that …
    1. is involved in the production of haploid cells in plants.
    2. is responsible for giving organisms their phenotypic appearance.
    3. helps plants to grow in height
    4. is responsible for mutations in all organisms.
    5. organisms can do without it.
    6. I do not know

71. What is the phenotype ratio in a cross between two heterozygous tall plants?
    1. 4:1
    2. 1:2:1
    3. 9:3:3:1
    4. 3:1
    5. 1:1
    6. I do not know.

72. What is an anticodon?
    1. The part of a tRNA that accepts an amino acid.
    2. The part of an mRNA that synthesises join molecules together.
    3. The part of an mRNA that signals termination of translation.
    4. The part of a tRNA that binds to a codon on mRNA.
    5. The part of an mRNA that signals the beginning of translation.
    6. I do not know.

73. Why are genes involved in lactose metabolism considered to be an operon?
    1. They occupy different locations on the *E. coli* chromosome.
    2. They produce proteins that inhibit the intake of lactose.
    3. They are controlled by separate promoters.
    4. They are all required for the same function at the same time
    5. They have different functions from each other.
    6. I do not know.

74. All of the following are involved in translation, except …
    1. tRNA.
    2. start codon
    3. Stop codon
    4. Ribosome
    5. DNA
    6. I do not know

75. Under which of the following conditions will transcription of the *lac* operon occur?
    1. Absence of lactose.
    2. Presence of amino acids.
    3. Presence of lactose
    4. Presence of ribonucleic acid
    5. Presence of lipids.
    6. I do not know

76. Identify the correct statement from the following:
A daughter cell is most likely to inherit from a parent a change in ...
1. the number of chromosomes in a nucleus.
2. the type of mRNA
3. the type of tRNA
4. a nucleotide base sequence
5. The type of rRNA.
6. I do not know

77. Which one of the following statements about gene expression is true?
1. RNA polymerase is responsible for transcribing all the structural genes on to mRNA.
2. More than one ribosome is involved in translation.
3. A terminator codon normally stops transcription.
4. Some amino acids are coded for by more than one codon.
5. All the above statements are true
6. I do not know

78. The following is a segment of mRNA nucleotide sequence.

mRNA base sequence: 5' ...ACUCCUGAAUGCAAA... 3'

Identify which one of the following nucleotide sequences will be the tRNA anticodons.
1. UUUGCAUUCAGGAGU
2. ACUCCUGAAUGCAAA
3. AAACGUAAGUCCUCA
4. UGAGGACUUACGUUU
5. UCAUCCAAGCGUAAA
6. I do not know

79. Which one of the following statements is correct?
DNA strands have a polarity because ...
1. of its glycosidic bonds in the back bone molecules.
2. of its nitrogen bases contain hydrophilic amino groups.
3. of its negative charge on the phosphate group/groups
4. it has strong nitrogen bases.
5. of its sugar phosphate backbone.
6. I do not know

80. Transcription is ...
1. The act of copying hereditary information stored in DNA into RNA
2. The creation of an exact copy of DNA.
3. Involves production of proteins.
4. The act of transforming hereditary information into DNA.
5. The act of synthesising polypeptides by DNA.
6. I do not know

81. Why are the mRNA transcripts much shorter than the primary transcripts in eukaryotes?
    1. Because they get shortened by mutations.
    2. Because introns are removed from primary RNA transcripts.
    3. Because some nucleotide bases get knocked out by enzymes.
    4. So that they can fit within the cytoplasm of a cell.
    5. Because very little hereditary information is required on them.
    6. I do not know

82. How many alleles are involved in the ABO human blood groups?
    1. 1 allele
    2. 4 allele
    3. 2 allele
    4. 5 allele
    5. 3 alleles
    6. I do not know

83. In which of the following is mitosis not involved?
    1. Sperm production
    2. Replacement of epidermis in the skin.
    3. Production of identical daughter cells.
    4. Tissue repair
    5. Growth
    6. I do not know

84. During meiosis chiasma formation between chromosomes occurs during ..
    1. metaphase
    2. anaphase
    3. prophase
    4. interphase
    5. telophase
    6. I do not know

85. Epistasis is ...
    1. the inhibition of expression of one gene by another
    2. an interaction between two genes.
    3. an expression of codominance between two genes.
    4. enhancement of expression of one gene by another
    5. the same as incomplete dominance.
    6. I do not know

86. Which stage in the cell cycle takes the longest time?
    1. prophase
    2. metaphase
    3. anaphase
    4. interphase
    5. telophase
    6. I do not know

87. Which of the following phases in cell division does crossover of chromosomes take place?
1. Diplotene
2. Pachytene
3. Leptotene
4. Telophase
5. metaphase
6. I do not know

88. Which one of the following statements is **not** a characteristic of meiosis?
1. Duplication of centromeres during meiosis II.
2. Produces genetically different daughter cells.
3. Consists of two consecutive cell divisions.
4. It occurs in somatic cells of organisms.
5. Helps to restore the haploid condition of somatic cells.
6. I do not know

89. The type of bond that holds the two strands of DNA are …
1. covalent
2. ionic
3. Electrostatic
4. polar
5. hydrophobic interaction
6. I do not know

90. Which one of the following has an autonomous DNA?
1. Mitochondria
2. Golgi apparatus
3. Ribosomes
4. Endoplasmic reticulum
5. Lysosomes
6. I do not know

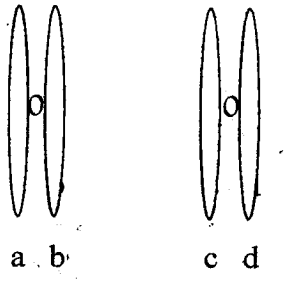
91. Given the following sequence of nucleotide bases of mRNA strand, determine how tRNA would read the codons on mRNA.
mRNA strand: 5'' …UAGCCGAUGUA…3'

1. 3'…AUG UAG CCG AU… 5'
2. 5'…AUC GG CUA CAU… 3'
3. 3'…UA GC CG AU GU A… 5'
4. 5'…UAG CCG AUG UA…3'
5. 3' …UAGC CGAU GUA… 5'
6. I do not know.

92. Which of the following statements is **correct**?
1. Methionine is a terminator amino acid in the process of translation.
2. RNA is synthesised by translation.
3. DNA is a template for all RNA production.
4. Chromosomes are visible under the microscope during G1 phase of mitosis.
5. The environment does not contribute to the phenotype of an individual.
6. I do not know.

93. What are the constituent molecules of DNA?
1. amino acids, monosaccharide sugars and nitrogenous bases.
2. ribose sugars, phosphate groups and nitrogenous bases.
3. ribose sugars, lipids and proteins
4. ribose sugars, proteins and amino acids.
5. deoxyribose sugars, phosphate groups and nitrogenous bases.
6. I do not know.

94.



a and b are sister chromatids and so are chromatids c and d.

Crossing over cannot take place between ...
1. a and b
2. a and c
3. a and d
4. b and c
5. b and d
6. I do not know

95. Alleles ...
1. are always dominant.
2. are alternative forms of genes
3. alleles are linked to one another during inheritance.
4. are always beneficial.
5. control the same traits that are found on different loci of a chromosome.
6. I do not know.

96. Which of the following would genetics **not** be useful?
1. beverage industry
2. waste management
3. agriculture
4. construction industry
5. medicine
6. I do not know.

97. Height in a population is an example of ...
1. continuous variation.
2. discontinuous variation.
3. polyploidy variation.
4. codominance
5. incomplete dominance
6. I do not know.

98. A dominant allele is one which …
1. is present in a homozygous genotype.
2. occurs in a heterozygous genotype only.
3. has more influence in the recessive condition.
4. overshadows the effects of another allele.
5. fails to express itself in the presence of a recessive allele.
6. I do not know

99. The study of genetics has contributed to the understanding of the gradual development of organisms for billions of years to date. The field of study that traces the gradual change of organisms to fit the changing circumstances around them for their survival is called …
1. physiology
2. evolution.
3. ecology
4. embryology
5. anatomy
6. I do not know

100. In pea plants the gene for red (R) flowers and round seeds (S) are dominant. If two parent plants were crossed whose genotypes are RrSS and rrSs, what would be the genotype ratio of the offspring?
1. 1(RrSS) : 2(RrSs) : 2(rrSS) : 1(rrSs)
2. 9(RrSS) : 3(RrSs) : 3(rrSS) : 1(rrSs)
3. 2(RrSS) : 2(RrSs) : 1(rrSS) : 1(rrSs)
4. 1(RrSS) : 1(RrSs) : 1(rrSS) : 1(rrSs)
5. 4(RrSS) : 4(RrSs) : 1(rrSS) : 1(rrSs)
6. I do not know

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BIO 2032: BASIC MICROBIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. CHOOSE **THREE** QUESTIONS FROM SECTION A AND **TWO** FROM SECTION B.
USE ILLUSTRATIONS WHEREVER NECESSARY

SECTION A: Bacteriology

1. (a) Describe bacterial cell structure and its modifications giving an appropriate example of each modification type.
   (b) Describe a procedure that allows bacterial differentiation into two major groups.

2. Describe cytoplasmic inclusions found in bacterial cells in relation to their structure and function.

3. Describe conjugation in bacteria and explain the different ways by which it is achieved.

4. (a) Describe the soil microbial flora with special reference to diversity and density of each group of microbes present in the soil.
   (b) Explain the importance of soil microbes.

5. Describe the structure and chemical composition of the bacterial capsule and its role in bacteria.

SECTION B: Virology

6. Describe the Human Immunodeficiency Virus (HIV) with reference to:
   (a) morphology and genome.
   (b) mechanism of genome replication and
   (c) why efforts to develop a vaccine against HIV have remained unsuccessful.

TURN OVER

7. Describe four different viral genome types and explain the mechanisms of their replication.

8. Summarise ANY THREE of the following:
   (a) Different mechanisms of viral animal diseases.
   (b) A comparison and contrast of viroids and prions.
   (c) Retroviruses.
   (d) Methods of culturing viruses in the laboratory.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BIO 2062: DIVERSITY OF ANIMALS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. **TWO** QUESTIONS FROM EACH SECTION AND THE **FIFTH** FROM EITHER SECTION. USE ILLUSTRATIONS WHERE POSSIBLE AND USE SEPARATE BOOKLETS FOR EACH SECTION.

SECTION A: Invertebrates

1. Summarise the following;
   (a) Pseudopodial action in protozoans
   (b) Biology of monogeneans
   (c) Filter feeding in members of the Phylum Porifera
   (d) Significant role of nematodes found in the Class Phasmidia
   (e) General characteristics of molluscs

2. Describe the main distinguishing features among the four classes of the Phylum Cnidaria.

3. Compare and contrast morphological features found in members of the Class Oligochaeta and Class Hirudinomorpha.

4. Explain how members of the Subphylum Mandibulata have adapted to their respective habitats.

SECTION B: Vertebrates

5. Describe respiration in the different groups of reptiles.

6. (a) Describe the general characteristics of extant agnathans.
   (b) Explain how extant agnathans differ from other vertebrates

7. Summarise the following:
   (a) The major changes that occur when amphibian larvae undergo metamorphosis to become terrestrial adults.
   (b) Skeletal structure in the three extant classes of fish.
   (c) Structure of an amniotic egg.
   (d) The adaptations of the avian skeleton to birds' capacity to fly.

8. Describe the characteristics of mammals stating whether each characteristic is unique to the class or is shared by other vertebrate groups. Give examples.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BIO2085: INTRODUCTION TO BIOSTATISTICS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS.USE THE STATISTICAL TABLES PROVIDED.

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1. (a) State the type of measurement scale (nominal, ordinal, interval or ratio) each of the following represent:
   Weight
   (i) Distance
   (ii) Birthplace
   (iii)Heart rate
   (iv)Third place in a race
   (v) Eye colour
   (vi)Three best text books

   (b) Suppose we know that 10% of young girls in Zambia are malnourished, 5% are anaemic, and that we are interested in the relationship between the two. Suppose we also know that 50% of anaemic girls are also malnourished. Determine the probability that a malnourished girl is also anaemic.

2. The following is a hypothetical list of the ages of a sample of lecturers in the Department of Biological Sciences.

   37 42 51 38 45 50 31 44 34 39 52 40 41 36 32

   Calculate
   (a) The mean age of the sample.
   (b) The median age of the sample.
   (c) Given that the population standard deviation is 6.61 and the population mean is 43 years, calculate:
   (i) The proportion of lecturers older than 40 years.
   (ii) The proportion of lecturers younger than 50 years.

TURN OVER

3. (a) A researcher is planning to investigate the relationship between the social class of hospitalized children and the frequency and content of children-initiated communications with the nursing staff.
   (i) Identify the independent and the dependent variable.
   (ii) State whether this research can be classified as basically experimental or correlational, or whether both approaches could be used be used?

   (b) The Ministry of Health is interested in knowing the prevalence (proportion with the condition) of a new parasite among rodents in Zambia. The parasite can be transmitted to cattle and cause severe disease in Jersey cows. Faecal samples from 300 rodents and 400 cows are collected at random from southern province. During cold season, no cows in Choma show symptoms of the parasite. Identify the:
   (i) Target population.
   (ii) Study population.
   (iii)Sample population.

4. The consumption of fresh fruits in a certain urban community is expected to be significantly different for the male and the female populations, since men tend not to like vegetables and prefer meat. In order to investigate whether women eat more vegetables than men, the monthly consumption in kilograms (Kg) was recorded for one sample of men and one for women. The frequency distribution in class intervals is given in table 1. Using the Chi-squared test, determine whether the expressed hypothesis is confirmed by this data.

   Table 1: Monthly consumption of fresh fruit in Kg among women and men

Amount of vegetables(Kg)	Number of women	Number of men
0-1	120	375
2-3	224	112
4-5	78	34
6-7	18	8

5. In order to determine the effect of the drug Mebendazole on the intensity of worm infections in a group of school children, the amount of worm infection in each child was determined at the beginning of the experiment. All children were given the drug, and the intensity of infection was measured again 36 hours after administering the drug. The results in table 2 show the children's identities and the intensity of infection (worm eggs per gram of faeces) before and after administering the drug. Use a Student *t*-test to determine whether the infection intensity differs significantly in the children before and after taking the drug.

CONTINUE TO THE NEXT PAGE

Table 2: Intensity of worm infections (worm eggs per gram of faeces) in a group of school children before and after treatment with mebendazole

Child ID	Intensity before treatment	Intensity after treatment
1	12	10
2	34	20
3	1	1
4	0	0
5	22	21
6	100	102
7	3	2
8	45	42
9	54	60
10	3	2

6. Table 3 gives the scores of height(x) of boys and their weight (y) in a school. Compute the Pearson's correlation coefficient and determine whether the correlation is significant or not at $\alpha = 0.05$.

Table 3: Height and Weight of boys in a school

ID of Boy	Height	Weight
1	82	42
2	98	46
3	87	39
4	40	37
5	116	68
6	113	88
7	111	86
8	83	56
9	85	62
10	126	92
11	106	54
12	117	81

7. A health centre has recorded the monthly cases of malaria (x) and of measles (y). A medical assistant presumes that there is some relationship between the occurrences of these two diseases in his community. Based on the collected data given in table 4, Establish the regression equation.
   (a) Estimate the number of cases of measles to expect in a month when 15 cases of malaria are recoded.
   (b) Estimate the number of cases of malaria in a month when 25 cases of measles are recorded.

TURN OVER

Table 4: Monthly number of cases of malaria and measles observed at a health centre

Month	Cases of malaria	Cases of measles
January	14	19
February	66	11
March	12	7
April	8	18
May	10	5
June	3	24
July	5	16
August	6	22

8. Argue whether each of the following pairs of events are independent or dependent and whether they are mutually exclusive or not:

(a) To drive an expensive car and to weigh 98kg
(b) To drive a sports car and to over speed
(c) To drive after drinking alcohol and to cause an accident
(d) To live in Lusaka and to go for a walk on the beach every day
(e) To be born in May and to have one's birthday on June 5
(f) To be five days old and be 1.78m tall

END OF EXAMINATION

Appendix 1 Critical values for Student's *t*-distribution

df is the degrees of freedom

	Significance				
df	1-tailed: 0.05 2-tailed: 0.10	0.025 0.050	0.010 0.020	0.005 0.010	0.0005 0.0010
1	6.314	12.706	31.821	63.657	636.619
2	2.920	4.303	6.965	9.925	31.599
3	2.353	3.182	4.541	5.841	12.924
4	2.132	2.776	3.747	4.604	8.610
5	2.015	2.571	3.365	4.032	6.869
6	1.943	2.447	3.143	3.707	5.959
7	1.895	2.365	2.998	3.499	5.408
8	1.860	2.306	2.896	3.355	5.041
9	1.833	2.262	2.821	3.250	4.781
10	1.812	2.228	2.764	3.169	4.587
11	1.796	2.201	2.718	3.106	4.437
12	1.782	2.179	2.681	3.055	4.318
13	1.771	2.160	2.650	3.012	4.221
14	1.761	2.145	2.624	2.977	4.140
15	1.753	2.131	2.602	2.947	4.073
16	1.746	2.120	2.583	2.921	4.015
17	1.740	2.110	2.567	2.898	3.965
18	1.734	2.101	2.552	2.878	3.922
19	1.729	2.093	2.539	2.861	3.883
20	1.725	2.086	2.528	2.845	3.850
21	1.721	2.080	2.518	2.831	3.819
22	1.717	2.074	2.508	2.819	3.792
23	1.714	2.069	2.500	2.807	3.767
24	1.711	2.064	2.492	2.797	3.745
25	1.798	2.060	2.485	2.787	3.725
26	1.706	2.056	2.479	2.779	3.707
27	1.703	2.052	2.473	2.771	3.690
28	1.701	2.048	2.467	2.763	3.674
29	1.699	2.045	2.462	2.756	3.659
30	1.697	2.042	2.457	2.750	3.646
40	1.684	2.021	2.423	2.704	3.551
60	1.671	2.000	2.390	2.660	3.460
80	1.644	1.990	2.374	2.639	3.416
100	1.660	1.984	2.364	2.626	3.390
120	1.658	1.980	2.358	2.617	3.373
1000	1.646	1.962	2.330	2.581	3.300
∞	1.645	1.960	2.326	2.576	3.291

Appendix D
The CHI Square Distribution

Critical Values of CHI Square

	α levels				
df	.10	.05	.02	.01	.001
1	2.71	3.84	5.41	6.64	10.38
2	4.60	5.99	7.82	9.21	13.82
3	6.25	7.82	9.84	11.34	16.27
4	7.78	9.49	11.67	13.28	18.46
5	9.24	11.07	13.39	15.09	20.52
6	10.64	12.59	15.03	16.81	22.46
7	12.02	14.07	16.62	18.48	24.32
8	13.36	15.51	18.17	20.09	26.12
9	14.68	16.92	19.68	21.67	27.88
10	15.99	18.31	21.16	23.21	29.59
11	17.28	19.68	22.62	24.72	31.26
12	18.55	21.03	24.05	26.22	32.91
13	19.81	22.36	25.47	27.69	34.53
14	21.06	23.68	26.87	29.14	36.12
15	22.31	25.00	28.26	30.58	37.70
16	23.54	26.30	29.63	32.00	39.25
17	24.77	27.59	31.00	33.41	40.79
18	25.99	28.87	32.35	34.80	42.31
19	27.20	30.14	33.69	36.19	43.82
20	28.41	31.41	35.02	37.57	45.32
21	29.62	32.67	36.34	38.93	46.80
22	30.81	33.92	37.66	40.29	48.27
23	32.01	35.17	38.97	41.64	49.73
24	33.20	36.42	40.27	42.98	51.18
25	34.38	37.65	41.57	44.31	52.62
26	35.56	38.88	42.86	45.64	54.05
27	36.74	40.11	44.14	46.96	55.48
28	37.92	41.34	45.42	48.28	56.89
29	39.09	42.56	46.69	49.59	58.30
30	40.26	43.77	47.96	50.89	59.70

Source: This table is taken from Table IV of Fisher and Yates. *Statistical Tables for Biological, Agricultural and Medical Research*, published by Longman Group Ltd., London (previously published by Oliver and Boyd, Ltd., Edinburgh), and by permission of the authors and publishers.
Note: Reject null hypothesis if obtained chi square is equal to or greater than the tabled value.

Appendix 2 Critical values for Snedecor's *F*-test (2-tailed, 0.05 level of significance)

df_1 and **df_2** are the degrees of freedom for the greater and lesser variances, respectively

df_2 \ df_1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	647.80	799.50	864.20	899.60	921.80	937.10	948.20	956.70	963.30	968.60	976.70	984.90	993.10	997.20	1001	1006	1010	1014	1018
2	38.51	39.00	39.17	39.25	39.30	39.33	39.36	39.37	39.39	39.40	39.41	39.43	39.45	39.46	39.46	39.47	39.48	39.49	39.50
3	17.44	16.04	15.44	15.10	14.88	14.73	14.62	14.54	14.47	14.42	14.34	14.25	14.17	14.12	14.08	14.04	13.99	13.95	13.90
4	12.22	10.65	9.98	9.60	9.36	9.20	9.07	8.98	8.90	8.84	8.75	8.66	8.56	8.51	8.46	8.41	8.36	8.31	8.26
5	10.01	8.43	7.76	7.39	7.15	6.98	6.85	6.76	6.68	6.62	6.52	6.43	6.33	6.28	6.23	6.18	6.12	6.07	6.02
6	8.81	7.26	6.60	6.23	5.99	5.82	5.70	5.60	5.52	5.46	5.37	5.27	5.17	5.12	5.07	5.01	4.96	4.90	4.85
7	8.07	6.54	5.89	5.52	5.29	5.12	4.99	4.90	4.82	4.76	4.67	4.57	4.47	4.42	4.36	4.31	4.25	4.20	4.14
8	7.57	6.06	5.42	5.05	4.82	4.65	4.53	4.43	4.36	4.30	4.20	4.10	4.00	3.95	3.89	3.84	3.78	3.73	3.67
9	7.21	5.71	5.08	4.72	4.48	4.32	4.20	4.10	4.03	3.96	3.87	3.77	3.67	3.61	3.56	3.51	3.45	3.39	3.33
10	6.94	5.46	4.83	4.47	4.24	4.07	3.95	3.85	3.78	3.72	3.62	3.52	3.42	3.37	3.31	3.26	3.20	3.14	3.08
11	6.72	5.26	4.63	4.28	4.04	3.88	3.76	3.66	3.59	3.53	3.43	3.33	3.23	3.17	3.12	3.06	3.00	2.94	2.88
12	6.55	5.10	4.47	4.12	3.89	3.73	3.61	3.51	3.44	3.37	3.28	3.18	3.07	3.02	2.96	2.91	2.85	2.79	2.72
13	6.41	4.97	4.35	4.00	3.77	3.60	3.48	3.39	3.31	3.25	3.15	3.05	2.95	2.89	2.84	2.78	2.72	2.66	2.60
14	6.30	4.86	4.24	3.89	3.66	3.50	3.38	3.29	3.21	3.15	3.05	2.95	2.84	2.79	2.73	2.67	2.61	2.55	2.49
15	6.20	4.77	4.15	3.80	3.58	3.41	3.29	3.20	3.12	3.06	2.96	2.86	2.76	2.70	2.64	2.59	2.52	2.46	2.40
16	6.12	4.69	4.08	3.73	3.50	3.34	3.22	3.12	3.05	2.99	2.89	2.79	2.68	2.63	2.57	2.51	2.45	2.38	2.32
17	6.04	4.62	4.01	3.66	3.44	3.28	3.16	3.06	2.98	2.92	2.82	2.72	2.62	2.56	2.50	2.44	2.38	2.32	2.25
18	5.98	4.56	3.95	3.61	3.38	3.22	3.10	3.01	2.93	2.87	2.77	2.67	2.56	2.50	2.44	2.38	2.32	2.26	2.19
19	5.92	4.51	3.90	3.56	3.33	3.17	3.05	2.96	2.88	2.82	2.72	2.62	2.51	2.45	2.39	2.33	2.27	2.20	2.13
20	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84	2.77	2.68	2.57	2.46	2.41	2.35	2.29	2.22	2.16	2.09
21	5.83	4.42	3.82	3.48	3.25	3.09	2.97	2.87	2.80	2.73	2.64	2.53	2.42	2.37	2.31	2.25	2.18	2.11	2.04
22	5.79	4.38	3.78	3.44	3.22	3.05	2.93	2.84	2.76	2.70	2.60	2.50	2.39	2.33	2.27	2.21	2.14	2.08	2.00
23	5.75	4.35	3.75	3.41	3.18	3.02	2.90	2.81	2.73	2.67	2.57	2.47	2.36	2.30	2.24	2.18	2.11	2.04	1.97
24	5.72	4.32	3.72	3.38	3.15	2.99	2.87	2.78	2.70	2.64	2.54	2.44	2.33	2.27	2.21	2.15	2.08	2.01	1.94
25	5.69	4.29	3.69	3.35	3.13	2.97	2.85	2.75	2.68	2.61	2.51	2.41	2.30	2.24	2.18	2.12	2.05	1.98	1.91
26	5.66	4.27	3.67	3.33	3.10	2.94	2.82	2.73	2.65	2.59	2.49	2.39	2.28	2.22	2.16	2.09	2.03	1.95	1.88
27	5.63	4.24	3.65	3.31	3.08	2.92	2.80	2.71	2.63	2.57	2.47	2.36	2.25	2.19	2.13	2.07	2.00	1.93	1.85
28	5.61	4.22	3.63	3.29	3.06	2.90	2.78	2.69	2.61	2.55	2.45	2.34	2.23	2.17	2.11	2.05	1.98	1.91	1.83
29	5.59	4.20	3.61	3.27	3.04	2.88	2.76	2.67	2.59	2.53	2.43	2.32	2.21	2.15	2.09	2.03	1.96	1.89	1.81
30	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57	2.51	2.41	2.31	2.20	2.14	2.07	2.01	1.94	1.87	1.79
40	5.42	4.05	3.46	3.13	2.90	2.74	2.62	2.53	2.45	2.39	2.29	2.18	2.07	2.01	1.94	1.88	1.80	1.72	1.64
60	5.29	3.93	3.34	3.01	2.79	2.63	2.51	2.41	2.33	2.27	2.17	2.06	1.94	1.88	1.82	1.74	1.67	1.58	1.48
120	5.15	3.80	3.23	2.89	2.67	2.52	2.39	2.30	2.22	2.16	2.05	1.94	1.82	1.76	1.69	1.61	1.53	1.43	1.31
∞	5.02	3.69	3.12	2.79	2.57	2.41	2.29	2.19	2.11	2.05	1.94	1.83	1.71	1.64	1.57	1.48	1.39	1.27	1.00

TABLE I Proportions of Area under the Standard Normal Curve

z	O z	O z	z	O z	O z	z	O z	O z
0.00	.0000	.5000	0.55	.2088	.2912	1.10	.3643	.1357
0.01	.0040	.4960	0.56	.2123	.2877	1.11	.3665	.1335
0.02	.0080	.4920	0.57	.2157	.2843	1.12	.3686	.1314
0.03	.0120	.4880	0.58	.2190	.2810	1.13	.3708	.1292
0.04	.0160	.4840	0.59	.2224	.2776	1.14	.3729	.1271
0.05	.0199	.4801	0.60	.2257	.2743	1.15	.3749	.1251
0.06	.0239	.4761	0.61	.2291	.2709	1.16	.3770	.1230
0.07	.0279	.4721	0.62	.2324	.2676	1.17	.3790	.1210
0.08	.0319	.4681	0.63	.2357	.2643	1.18	.3810	.1190
0.09	.0359	.4641	0.64	.2389	.2611	1.19	.3830	.1170
0.10	.0398	.4602	0.65	.2422	.2578	1.20	.3849	.1151
0.11	.0438	.4562	0.66	.2454	.2546	1.21	.3869	.1131
0.12	.0478	.4522	0.67	.2486	.2514	1.22	.3888	.1112
0.13	.0517	.4483	0.68	.2517	.2483	1.23	.3907	.1093
0.14	.0557	.4443	0.69	.2549	.2451	1.24	.3925	.1075
0.15	.0596	.4404	0.70	.2580	.2420	1.25	.3944	.1056
0.16	.0636	.4364	0.71	.2611	.2389	1.26	.3962	.1038
0.17	.0675	.4325	0.72	.2642	.2358	1.27	.3980	.1020
0.18	.0714	.4286	0.73	.2673	.2327	1.28	.3997	.1003
0.19	.0753	.4247	0.74	.2704	.2296	1.29	.4015	.0985
0.20	.0793	.4207	0.75	.2734	.2266	1.30	.4032	.0968
0.21	.0832	.4168	0.76	.2764	.2236	1.31	.4049	.0951
0.22	.0871	.4129	0.77	.2794	.2206	1.32	.4066	.0934
0.23	.0910	.4090	0.78	.2823	.2177	1.33	.4082	.0918
0.24	.0948	.4052	0.79	.2852	.2148	1.34	.4099	.0901
0.25	.0987	.4013	0.80	.2881	.2119	1.35	.4115	.0885
0.26	.1026	.3974	0.81	.2910	.2090	1.36	.4131	.0869
0.27	.1064	.3936	0.82	.2939	.2061	1.37	.4147	.0853
0.28	.1103	.3897	0.83	.2967	.2033	1.38	.4162	.0838
0.29	.1141	.3859	0.84	.2995	.2005	1.39	.4177	.0823
0.30	.1179	.3821	0.85	.3023	.1977	1.40	.4192	.0808
0.31	.1217	.3783	0.86	.3051	.1949	1.41	.4207	.0793
0.32	.1255	.3745	0.87	.3078	.1922	1.42	.4222	.0778
0.33	.1293	.3707	0.88	.3106	.1894	1.43	.4236	.0764
0.34	.1331	.3669	0.89	.3133	.1867	1.44	.4251	.0749
0.35	.1368	.3632	0.90	.3159	.1841	1.45	.4265	.0735
0.36	.1406	.3594	0.91	.3186	.1814	1.46	.4279	.0721
0.37	.1443	.3557	0.92	.3212	.1788	1.47	.4292	.0708
0.38	.1480	.3520	0.93	.3238	.1762	1.48	.4306	.0694
0.39	.1517	.3483	0.94	.3264	.1736	1.49	.4319	.0681
0.40	.1554	.3446	0.95	.3289	.1711	1.50	.4332	.0668
0.41	.1591	.3409	0.96	.3315	.1685	1.51	.4345	.0655
0.42	.1628	.3372	0.97	.3340	.1660	1.52	.4357	.0643
0.43	.1664	.3336	0.98	.3365	.1635	1.53	.4370	.0630
0.44	.1700	.3300	0.99	.3389	.1611	1.54	.4382	.0618
0.45	.1736	.3264	1.00	.3413	.1587	1.55	.4394	.0606
0.46	.1772	.3228	1.01	.3438	.1562	1.56	.4406	.0594
0.47	.1808	.3192	1.02	.3461	.1539	1.57	.4418	.0582
0.48	.1844	.3156	1.03	.3485	.1515	1.58	.4429	.0571
0.49	.1879	.3121	1.04	.3508	.1492	1.59	.4441	.0559
0.50	.1915	.3085	1.05	.3531	.1469	1.60	.4452	.0548
0.51	.1950	.3050	1.06	.3554	.1446	1.61	.4463	.0537
0.52	.1985	.3015	1.07	.3577	.1423	1.62	.4474	.0526
0.53	.2019	.2981	1.08	.3599	.1401	1.63	.4484	.0516
0.54	.2054	.2946	1.09	.3621	.1379	1.64	.4495	.0505

Table I (continued)

z	O z	O z	z	O z	O z	z	O z	O z
1.65	.4505	.0495	2.22	.4868	.0132	2.79	.4974	.0026
1.66	.4515	.0485	2.23	.4871	.0129	2.80	.4974	.0026
1.67	.4525	.0475	2.24	.4875	.0125	2.81	.4975	.0025
1.68	.4535	.0465	2.25	.4878	.0122	2.82	.4976	.0024
1.69	.4545	.0455	2.26	.4881	.0119	2.83	.4977	.0023
1.70	.4554	.0446	2.27	.4884	.0116	2.84	.4977	.0023
1.71	.4564	.0436	2.28	.4887	.0113	2.85	.4978	.0022
1.72	.4573	.0427	2.29	.4890	.0110	2.86	.4979	.0021
1.73	.4582	.0418	2.30	.4893	.0107	2.87	.4979	.0021
1.74	.4591	.0409	2.31	.4896	.0104	2.88	.4980	.0020
1.75	.4599	.0401	2.32	.4898	.0102	2.89	.4981	.0019
1.76	.4608	.0392	2.33	.4901	.0099	2.90	.4981	.0019
1.77	.4616	.0384	2.34	.4904	.0096	2.91	.4982	.0018
1.78	.4625	.0375	2.35	.4906	.0094	2.92	.4982	.0018
1.79	.4633	.0367	2.36	.4909	.0091	2.93	.4983	.0017
1.80	.4641	.0359	2.37	.4911	.0089	2.94	.4984	.0016
1.81	.4649	.0351	2.38	.4913	.0087	2.95	.4984	.0016
1.82	.4656	.0344	2.39	.4916	.0084	2.96	.4985	.0015
1.83	.4664	.0336	2.40	.4918	.0082	2.97	.4985	.0015
1.84	.4671	.0329	2.41	.4920	.0080	2.98	.4986	.0014
1.85	.4678	.0322	2.42	.4922	.0078	2.99	.4986	.0014
1.86	.4686	.0314	2.43	.4925	.0075	3.00	.4987	.0013
1.87	.4693	.0307	2.44	.4927	.0073	3.01	.4987	.0013
1.88	.4699	.0301	2.45	.4929	.0071	3.02	.4987	.0013
1.89	.4706	.0294	2.46	.4931	.0069	3.03	.4988	.0012
1.90	.4713	.0287	2.47	.4932	.0068	3.04	.4988	.0012
1.91	.4719	.0281	2.48	.4934	.0066	3.05	.4989	.0011
1.92	.4726	.0274	2.49	.4936	.0064	3.06	.4989	.0011
1.93	.4732	.0268	2.50	.4938	.0062	3.07	.4989	.0011
1.94	.4738	.0262	2.51	.4940	.0060	3.08	.4990	.0010
1.95	.4744	.0256	2.52	.4941	.0059	3.09	.4990	.0010
1.96	.4750	.0250	2.53	.4943	.0057	3.10	.4990	.0010
1.97	.4756	.0244	2.54	.4945	.0055	3.11	.4991	.0009
1.98	.4761	.0239	2.55	.4946	.0054	3.12	.4991	.0009
1.99	.4767	.0233	2.56	.4948	.0052	3.13	.4991	.0009
2.00	.4772	.0228	2.57	.4949	.0051	3.14	.4992	.0008
2.01	.4778	.0222	2.58	.4951	.0049	3.15	.4992	.0008
2.02	.4783	.0217	2.59	.4952	.0048	3.16	.4992	.0008
2.03	.4788	.0212	2.60	.4953	.0047	3.17	.4992	.0008
2.04	.4793	.0207	2.61	.4955	.0045	3.18	.4993	.0007
2.05	.4798	.0202	2.62	.4956	.0044	3.19	.4993	.0007
2.06	.4803	.0197	2.63	.4957	.0043	3.20	.4993	.0007
2.07	.4808	.0192	2.64	.4959	.0041	3.21	.4993	.0007
2.08	.4812	.0188	2.65	.4960	.0040	3.22	.4994	.0006
2.09	.4817	.0183	2.66	.4961	.0039	3.23	.4994	.0006
2.10	.4821	.0179	2.67	.4962	.0038	3.24	.4994	.0006
2.11	.4826	.0174	2.68	.4963	.0037	3.25	.4994	.0006
2.12	.4830	.0170	2.69	.4964	.0036	3.30	.4995	.0005
2.13	.4834	.0166	2.70	.4965	.0035	3.35	.4996	.0004
2.14	.4838	.0162	2.71	.4966	.0034	3.40	.4997	.0003
2.15	.4842	.0158	2.72	.4967	.0033	3.45	.4997	.0003
2.16	.4846	.0154	2.73	.4968	.0032	3.50	.4998	.0002
2.17	.4850	.0150	2.74	.4969	.0031	3.60	.4998	.0002
2.18	.4854	.0146	2.75	.4970	.0030	3.70	.4999	.0001
2.19	.4857	.0143	2.76	.4971	.0029	3.80	.4999	.0001
2.20	.4861	.0139	2.77	.4972	.0028	3.90	.49995	.0000
2.21	.4864	.0136	2.78	.4973	.0027	4.00	.49997	.0000

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 319: BIOSTATISTICS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS

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1. Two students from the Department of Biological Sciences at the University of Zambia were asked to observe and record numbers of feeding scars made by adult mottled water hyacinth weevil, *Neochetina eichhorniae* Warner on 10 separate Kafue weed leaves. The students produced the following data.

Table 1. Number of weevil feeding scars on Kafue weed leaves.

	Kafue Weed Leaf Number									
Student	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	54	20	29	91	42	89	23	54	20	14
2	43	16	52	21	31	18	90	43	31	11

(a) Test whether each student's sample of counts came from a normal distribution with $\sigma^2 = 492.13$
(b) Test the Null Hypothesis that the two samples have equal variances

2. The following data set is presented for your analysis:

x:	1	2	4	5	8	10	12	15
y:	5	10	16	18	35	40	46	58

(a) Display the data presented is a scatter plot.
(b) Fit a regression line to the scatter plot and,
(c) Test the significance of the regression.

TURN OVER

(b) Test the N.H. that rho equals zero.

6. In a report on a randomized block design (RBD) experiment, the following results were given. Treatment means: A = 50, B = 47, C = 62, D = 52, E = 54. The sum-of-squares for experimental error was 96, based on 32 degrees of freedom. The total sum-of- squares was 5824. Reconstruct the Analysis of Variance (ANOVA) table below and test the Null hypothesis that there are no significant differences among the treatment means.

Table 4. ANOVA table for Randomized Block Design experiment for question 4.

Source of Variation	d.f.	s.s.	m.s.	F-ratio
Treatments	-	-	-	-
Blocks	-	-	-	-
Error	-	-	-	
Total	-	-	-	

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

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

Examine the significance between the two sample means, assuming that their population variances were equal.

8. A supermarket organization buys a particular foodstuff from four suppliers A, B, C and D and subjects samples of this to regular tasting tests by expert panels. Various characteristics are scored, and the total score for the product is recorded. Four tasters a, b, c and d at four tasting sessions obtained the results below laid out using a Latin Square Design. Conduct an ANOVA to test the validity of the claim that the tests measure the same qualities of the foodstuff and that there are no differences between tasters and sessions.

Table 5. Latin Square Design layout data for question 8.

		Taster			
		a	**b**	**c**	**d**
Session	**1**	A: 18	B: 22	C: 18	D: 28
	2	B: 20	D: 22	A: 23	C: 12
	3	C: 20	A: 24	D: 27	B: 16
	4	D: 22	C: 21	B: 19	A: 30

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR FIRST SEMESTER FINAL EXAMINATIONS

BS 321: ETHOLOGY AND EVOLUTION
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. ANSWER QUESTIONS **ONE** AND **FOUR** OTHERS. ILLUSTRATE YOUR ANSWERS WHERE NECESSARY.

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1. Charles Darwin proposed that evolution by natural selection was the basis for the differences in similar organisms. Discuss in detail any **two** of the following:
   (a) The theory of evolution by Natural Selection as presented by Darwin.
   (b) Natural Selection and pesticide-resistant insect.
   (c) Speciation and its limitations.

2. Discuss the following concepts as used in evolution of species:
   (a) Teleology.
   (b) Kin selection.
   (c) Handicap Principle.
   (d) Genetic drift.

3. Discuss the Hardy-Weinberg law and its limitations in the evolution of species.

4. In the evolution of sex, discuss sexual selection with reference to:
   (a) Sex ratio in animal species.
   (b) Mating systems in vertebrate species.

5. Describe the main features of chemical communication in animal species, and explain how such communication could be an essential mechanism in prey species.

6. Discuss how imprinting behavior could be useful in both offspring and parents in precocial species such as ducks and geese.

7. Compare and contrast Character Displacement and Habituation in the evolution of species.
8. Discuss the main differences between Lamarckism and Darwinism as they relate to the evolution of altruistic behaviour in social species.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 332: ANIMAL PHYSIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS

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1. Explain urine formation in the mammalian kidney detailing how cells take up and retain glucose in the blood in the absence of a sugar concentration gradient between the nephron lumen and the interstitial fluid.

2. Describe the events that take place from the time a nerve impulse arrives at the neuromuscular junction to the commencement of the excitation-contraction coupling process.

3. Discuss the different orientations between medium flow and blood flow in different animal types and how these affect gas exchange efficiency.

4. Summarize ALL of the following:
   (a) Neurotransmitters.
   (b) Cyclic adenosine monophosphate (cAMP) second messenger mechanism.
   (c) Memory.
   (d) Photochemical changes in rhodopsin.

5. Compare and contrast the metabolic processes of nitrogenous waste excretion in fish, mammals and birds using clearly labeled diagrams.

6. Discuss the importance of calcium in animals and explain in detail the regulation of blood calcium levels.

7. Explain how glomerular filtration rate (GFR) is measured clearly showing how various parameters used to calculate GFR are derived.

TURN OVER

8. (a) Explain the events that underlie the initiation of heart beat by the pacemaker cells detailing the role of "funny" currents.
   (b) With the aid of a diagram explain the effects of norepinephrine on the mammalian heart rate.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 352: PARASITOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS; TWO QUESTIONS FROM EACH SECTION AND THE FIFTH QUESTION FROM EITHER SECTION. USE SEPERATE ANSWER BOOKLETS FOR EACH SECTION

SECTION A

1. Describe the transmission and pathogenesis of bovine trypanosomiasis.

2. Describe the life cycle of *Plasmodium vivax*.

3. Discuss opportunistic parasitic protozoa infections in relation to HIV/AIDS.

4. Describe transmission, life cycle and pathogenesis of *Entamoeba histolytica*.

SECTION B

5. Outline the processes that lead to the development of the following:
   (a) Cysticercosis in human hosts.
   (b) Granulomous formation in hosts infected with schistosomes parasites.

6. Compare and contrast the following phenomena:
   (a) Retro-infection in *Enterobius vermicularis* infections and auto-infection in *Strongyloides stercoralis*.
   (b) Morphology of *Ancylostoma duodenalis* and *Necator americanus*.

7. Describe the diagnostic features for the following parasitic infections:
   (a) *Taenia* species.
   (b) *Onchocerca vulvulus*.
   (c) *Trichinella spiralis*.

TURN OVER

8. Describe the following:
   (a) The feeding habits of phlebotomine sand flies
   (b) The breeding sites of *Anopheles*, *Culex* and *Aedes* mosquitoes.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 362: GENETICS
PRACTICAL PAPER

TIME: TWO HOURS

INSTRUCTIONS: ANSWER **ALL** QUESTIONS

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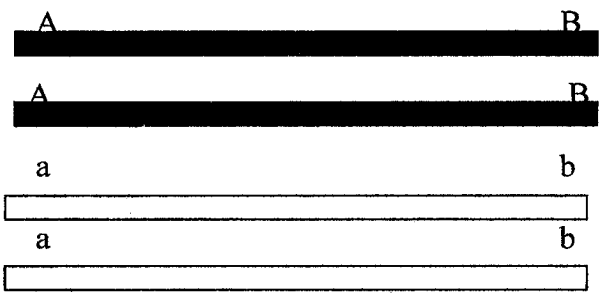
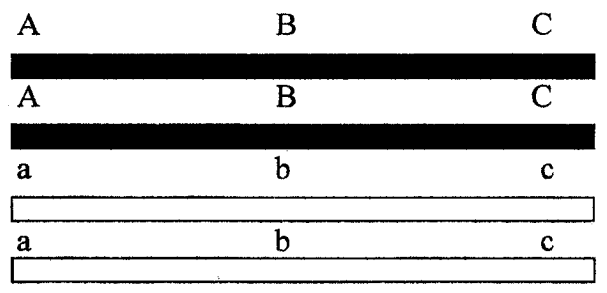
1. Examine the meiotic Chromosomes given below: Draw the meiotic products of the meiotic chromosomes in spaces provided, showing the crossover events (for both single and double cross over) relating to two and three linked genes.

	Meiotic Chromosomes	**Meiotic Products**
Parental chromosomes		Single Cross over - - - - - - - - - - - Double Cross over - - - - - - - - - - -
Parental chromosomes		Single Cross over - - - - - - - - - - - Double Cross over - - - - - - - - - - -

TURN OVER

2. In one triple test cross starting with parental types AA BB CC and aa bb cc, the F_2 progeny phenotypes and their numbers are shown below:

Progeny phenotypes	**No. of plants**	**A- B**	**A - C**	**B - C**
A B C	89			
a b c	71			
A b c	18			
a B c	27			
A b C	45			
a B C	40			
A B c	8			
a b C	12			
Totals	**310**			

Based on the information in the above table, answer the following questions:

(a) Calculate the X^2 value to see if the test of linkage fit a 1:1:1:1:1:1:1:1 ratio or not.
(b) Estimate the recombination frequencies.
(c) Determine the gene order and draw a map showing the distances between the loci.
(d) Calculate the value of the mean chiasma frequency.
(e) Determine the distance in centimorgan.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 412: APPLIED ENTOMOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUSETIONS, **TWO** QUESTIONS FROM EACH SECTION AND THE **FIFTH** FROM EITHER SECTION. USE ILLUSTRATIONS WHERE POSSIBLE AND USE SEPARATE BOOKLETS FOR EACH SECTION.

SECTION A

1. Discuss the relevance of pest populations' surveillance in determining economic thresholds.
2. Describe the most commonly used method of evaluating losses in field crops due to insect pest infestations.
3. Summarise four of the following;
   (a) General plant responses to insect damage
   (b) Environmental economic injury levels
   (c) Intensity of pest attack
   (d) Lifecycle of *Bombyx mori* L.
   (e) Use of insects in biological research
4. Describe the societal organization of the honey bees and in your answer, explain how certain biotic factors affect their survival.

SECTION B

5. Discuss the theme of the book, Silent Spring by R. Carlson (1962) and its relevance to the practice of Insect Pest Management (IPM).
6. Discuss the methods used in the implementation of biological control programmes.
7. (a) Describe the major classes of insecticides used to control insect pests in Zambia.
   (b) Explain why "alternative insecticides" might offer certain benefits in comparison to the major insecticides now in use.
8. Cotton (*Gossypium hirsutum* L.) is a fibre crop that is susceptible to attacks by many insect pests. Classify major cotton insect pests according to the nature of damage they cause to the cotton plant.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 445: ECOPHYSIOLOGY OF PLANTS
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS. USE ILLUSTRATIONS WHERE NECESSARY.

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1. Discuss how gaseous emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO and NO_2), from metallurgical industries and nitrogen chemical fertilizer factories respectively, affect plants and vegetation growing in environs of the places where such industrial activities take place.

2. (a) Explain how strong light intensities (high fluencies) affect quantum yield (carbon gain per mol photons absorbed) and net photosynthesis in leaves.
   (b) Outline the role of the xanthophyll cycle in protecting cells against the effects of high light intensity.

3. (a) Compare and contrast the mechanisms of CO_2 concentration and assimilation in the three variants of C_4 photosynthesis.
   (b) Explain why environmental conditions in tropical and subtropical regions favour C4 photosynthesis sub-types.

4. Compare and contrast drought stress and salt stress in plants with reference to their physiological effects, and discuss the mechanisms involved in drought resistance and salt tolerance.

5. Describe crassulacean acid metabolism (CAM), distinguishing between performance and expression, and discuss how CAM performance is affected by environmental input parameters, such as water availability, carbon dioxide (intercellular and atmospheric), mineral nutrients and atmospheric temperature.

6. Discuss the physiological factors that underlie biomass production and seed production in plants.

7. Discuss plant responses to elevated CO_2 concentration at the leaf, whole plant and canopy levels.

8. Compare and contrast quantum yield in C_3 and C_4 sub-types of photosynthesis.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 455: WILDLIFE ECOLOGY
THEORY PAPER

TIME: THREE (3) HOURS

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

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1. Discuss contributions of the following to wildlife management:
   (a) Jolly – Seber method.
   (b) Aldo Leopold.

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

3. Discuss the implications of island biogeography theory in selecting an area for establishing a wildlife reserve in Zambia

4. Discuss in detail the management application of any **TWO** of the following concepts as used in wildlife ecology:
   (a) Kidney / Fat Ratio Index.
   (b) King Census method and its modification.
   (c) Aerial census method
   (d) Point centred method

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

6. Describe features which would indicate that a wildlife species population was being overexploited, and prescribe measures most significant in reversing the trend.

7. Discuss the management application of the following concepts as used in wildlife population management:
   (a) Maximum Sustainable Yield.
   (b) Community Based Natural Resources Management (CBNRM).

8. Describe the procedure for determining a stocking rate in wildlife species and discuss its limitations.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009-2010 ACADEMIC YEAR: SECOND SEMESTER
FINAL EXAMINATIONS

BS 492: FISHERIES BIOLOGY
THEORY PAPER

TIME: THREE HOURS

INSTRUCTIONS: ANSWER **FIVE** QUESTIONS, QUESTIONS 1 AND 2 ARE COMPULSORY AND ANSWER ANY **THREE** OTHER QUETIONS. USE ILLUSTATIONS WHERE NECESSARY IN YOUR ANSWERS

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1. Discuss the following in relation to management of fisheries resources:
   (a) Breakeven point.
   (b) Technology creep.
   (c) Adaptive fisheries management.
   (d) Catch quota.
   (e) Minimum mesh size.

2. Different population models have been developed to show relationships between parent stock size and number of recruits in fish populations.
   (a) Describe two models that explain relationships between parent stock size and number of recruits.
   (b) Compare and contrast the two models described in (a) above.
   (c) Give reasons for variations in the number of recruits for different parent stock sizes.

3. Discuss the applications of fish length frequency data in estimating the von-Bertalanffy growth parameters k and L_∞

4. Explain the common techniques that are used to estimate fish growth rate indicating both advantages and disadvantages of each method.

5. Discuss methods that are used to estimate relative abundance of fish populations and applications of such data in the management of fish stocks.

6. Discuss the various methods that are used to approximate the total mortality coefficient in fish populations. Indicate data requirements for each method.

TURN OVER

7. Assess the advantages and disadvantages of a fishery management objective that aims at exploiting fish stocks the Maximum Sustainable Yield.

8. Discuss the origins, characteristics of a centralised fisheries management system in Zambia and difficulties faced in adopting other fishery management systems that would facilitate sustainable exploitation of fishery resources.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 – 2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

BS 925: BIOLOGY OF TERRESTRIAL VERTEBRATES
THEORY PAPER

TIME: THREE HOURS

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

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1. Compare and contrast Metatheria and Eutheria groups of animals.
2. Explain why adult members of the family Pipidae and order Urodela are described as being paedomorphic.
3. Summarise the following:
   (a) Urostyle.
   (b) Jacobson's organ.
   (c) Neoteny.
   (d) Autotomy.
4. Describe the characteristics of snakes which have led to the postulation that snakes evolved from amphisbaenians.
5. Compare and contrast *Varanus niloticus* and *Crocodylus niloticus* in terms of:
   (a) Appearance
   (b) Breeding biology.
   (c) Food habits.
   (d) Conservation status in Zambia.
6. Discuss characteristics of Class Aves which have enabled some of its members to fly.
7. Describe how members of the family Elapidae and Viperidae:
   (a) Track their prey.
   (b) Kill their prey.
8. Explain why shield reptiles are restricted to fewer habitats compared to scaled reptiles.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009/10 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C102: INTRODUCTORY CHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS TO CANDIDATES

1. Indicate your student **ID number (ONLY)** and **TG** number on ALL your answer booklets.

2. This examination paper consists of two **(2)** sections **A** and **B.**

3. Section **A** has ten **(10)** short answer questions [Total marks = **40**]

4. Section **B** has five **(5)** long answer questions [Total marks = **60**]
   Questions carry equal marks

5. **ANSWER ALL QUESTIONS IN SECTION A; AND ANSWER B1 AND ANY OTHER THREE QUESTIONS IN SECTION B.**

6. **ANSWER ALL QUESTIONS IN SECTION A IN THE MAIN BOOKLET**

7. **ANSWER SECTION B QUESTIONS EACH IN A SEPARATE BOOKLET**

YOU ARE REMINDED OF THE NEED TO ORGANIZE AND PRESENT YOUR WORK CLEARLY AND LOGICALY

USEFUL DATA

The Periodic Table of Elements

The Periodic Table of Elements is attached at the end of the Examination paper

Gas constant R

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

Pressure

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

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

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

Density of water

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

SECTION A **ANSWER ALL QUESTIONS**

Question A1

Half-life for the first order decomposition of a certain pesticide was found to be 10.2 years. If the present concentration of the pesticide in a lake is 3.1×10^{-5} g/ml, what was its concentration 5 years ago?

Question A2

What is the activation energy of a reaction, if the rate constant triples when the temperature is increased from 0 °C to 10 °C?

Question A3

The K_{sp} for $Fe(OH)_2$ is 4.1×10^{-15}. What is the approximate pH of a saturated solution of $Fe(OH)_2$?

Question A4

At high temperature and a total pressure 1 atmosphere, 20 % of the steam is dissociated into hydrogen and oxygen according to following equation. Calculate the partial pressure of each gas at equilibrium. Calculate the equilibrium constant K_p .

$$2H_2O(l) \rightleftharpoons 2H_2(g) + O_2(g)$$

Question A5

Water, ethanol and benzene have properties shown in the table below.

Substance	T_{bp}° (K)	ΔH_{vap} (kJ mol^{-1})
Water, H_2O	373.15	40.7
Ethanol, CH_3CH_2OH	351.45	38.6
Benzene, C_6H_6	353.25	30.6

(a) Identify the strongest intermolecular forces that exist in each of the above compounds.

(b) Looking at the data above, arrange the above substances in the order of their increasing vapour pressures at 50 °C.

(c) Arrange the above substances in the order of their increasing vapour pressures at their normal boiling points. Give reasons for your answer.

Question A6

The Clausius-Clapeyron equation for vapour pressure of ethyl ether is given by following linear equation:

$$y = -3{,}411.43x + 11.09$$

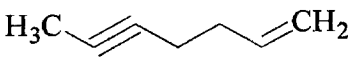
Determine the normal boiling point of ethyl ether in degrees centigrade.

Question A7

Determine the concentration of SO_2 in the liquid phase when the partial pressure of SO_2 is 270 mmHg. The Henry's constant for SO_2 at 30 °C is 1.69×10^{-3} mol/L mmHg.

Question A8

(a) Classify the following compound and provide its IUPAC name:



(b) Using Dash-line notation, write the structure of 3-bromo-2-oxo-pentanal.

Question A9

(a) Arrange the following molecular species in the order of **decreasing** stability.

$CH_3\overset{+}{C}HI$	$CH_3\overset{+}{C}H_2$	$CH_3\overset{+}{C}HCH_3$	$CH_3\overset{+}{C}HCl$
A	**B**	**C**	**D**

(b) State the hybridisation of carbocationic carbon in the molecular species **A** above.

Question A10

Give the structures of four isomers represented by the molecular formula C_5H_7Br.

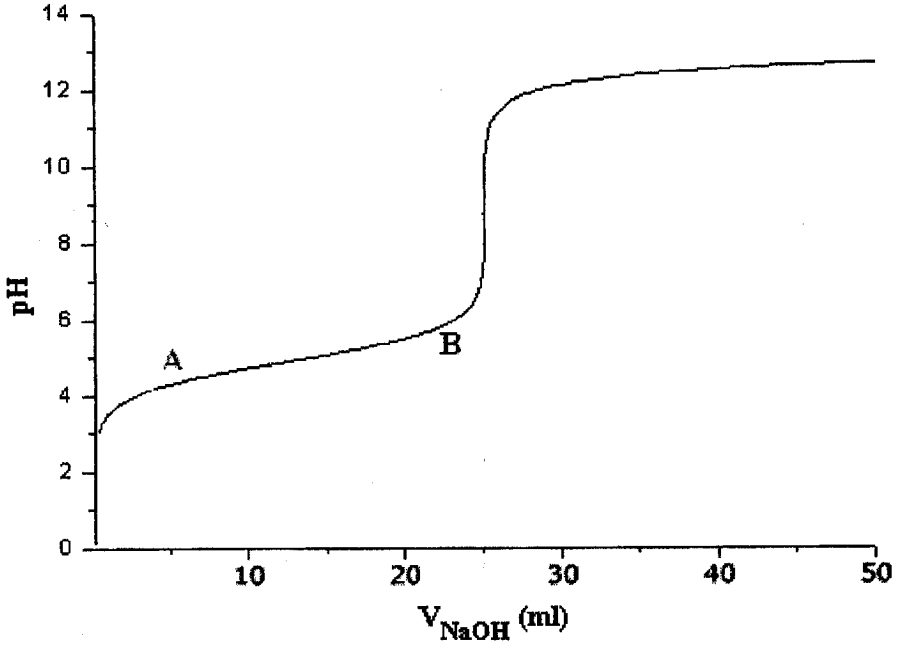
SECTION B **ANSWER B1, AND ANY THREE QUESTIONS EACH IN A SEPARATE BOOKLET**

Question B1

In Laboratory Experiment 5 you determined the acid dissociation constant, K_a, of a weak monobasic acid.

(a) One of the student used a pH curve to determine the p*K*a value of the weak monoprotic acid. She transferred 25.0 cm^3 of 0.100 M solution of the acid into a conical flask and measured the pH of the acid solution using a pH meter accurate to one decimal place. A solution of sodium hydroxide of concentration 0.100 mol dm^{-3} was added from a burette in small portions until the alkali was present in excess. The pH of the mixture was recorded after each addition of the sodium hydroxide solution.

Then she plotted the pH of the solution versus volume of alkali added from the burette and used this graph to determine the acid dissociation constant.



(i) Calculate mass of the acid required to prepare 100 cm^3 of 0.1 M solution of this acid. (Molar mass of the acid = 150 g mol^{-1})

(ii) What is the volume of sodium hydroxide added at the equivalence point?

(iii) What is the pH of the solution when half of the acid is neutralized.

(iv) What is the pKa of the acid? Show all your calculations.

(v) Explain why pH changes slowly between point A and B.

(b) Another student used the procedure given in Laboratory Manual to measure the volume required for neutralization of 25.0 cm^3 of acid by 0.100 M sodium hydroxide but used methyl red indicator instead of phenolphthalein.

The pH range for the two indicators are given below.

Indicator	**pH range for the colour change**
Methyl red	4.4 – 6.0
phenolphthalein	8.4 – 10.0

Justify, using the information given in table and the graph given in part B1 (a) why phenolphthalein is a suitable indicator for this titration.

Question B2

(a) At 298.15 K, the acid dissociation constant, K_a, for propanoic acid, CH_3CH_2COOH, is 1.35×10^{-5}.

(i) Write an expression for K_a for propanoic acid.

(ii) Calculate the pH of 0.125 mol dm^{-3} aqueous propanoic acid at 298.15 K.

(b) Sodium hydroxide reacts with propanoic acid as shown in the following equation:

$$NaOH + CH_3CH_2COOH \rightarrow CH_3CH_2COONa + H_2O$$

A buffer solution is formed when sodium hydroxide is added to an excess of aqueous propanoic acid.

(i) Calculate the number of moles of propanoic acid in 50.0 cm^3 of 0.125 mol dm^{-3} aqueous propanoic acid.

(ii) Use your answers to part (b)(i) to calculate the number of moles of propanoic acid in the buffer solution when 2.00 cm^3 of 0.500 mol dm^{-3} aqueous sodium hydroxide are added to 50.0 cm^3 of 0.125 mol dm^{-3} aqueous propanoic acid.

(iii) Hence calculate the pH of this buffer solution at 298.15 K.

Question B3.

A newly synthesized organic compound (a non-electrolyte) was analyzed, and its empirical formula was found as $\mathbf{C_3H_5O}$. A solution containing 0.702 g of the compound in 0.804 g of camphor was found to freeze at 15.3 °C lower than the freezing point of pure camphor. Camphor has the freezing point constant, $K_f = 40$ K kg mol^{-1}.

(a) Calculate the molar mass of the organic compound.

(b) Determine the molecular formula of the organic compound.

Question B4

Consider the solubility reaction below:

$$AgCl(s) + H_2O(l) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$

The enthalpy of formations in kJ/mol at 25 °C are shown below

Substance	ΔH_f° (kJ / mol)
AgCl(s)	-127.07
$Ag^+(aq)$	+105.58
$Cl^-(aq)$	-167.16

(a) Calculate the enthalpy of solution, ΔH_{sol}, using ΔH_f° data above.

(b) Using the data below and the van't Hoff equation, perform linear regression and calculate the enthalpy of solution of the above reaction.

t (°C)	**K_{SP}**	**T (K)**	**1/T**	**lnK_{SP}**
25	1.7785×10^{-10}	298.15	0.0033540	-22.450
30	2.742×10^{-10}	303.15	0.0032987	-22.017
40	6.3046×10^{-10}	313.15	0.0031934	-21.185

(c) Determine the **solubility** of AgCl in water at 35 °C using the K_{SP} value at 40 **°C** in the table above. [**Do not use the linear equation**]

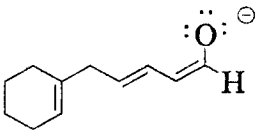
Question B5

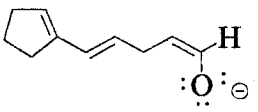
(a) (i) Based on your understanding of the carbon-carbon double bond (C=C), provide an explanation for the sensitivity of alkenes to proton acids.

(ii) The reaction of hydrobromic acid with propene at 25 ^{0}C gave two products, **P**: 2-bromopropane in 78 % yield and **Q**: 1-bromopropropane in 22 % yield. Provide appropriate reaction mechanisms to account for these experimental results.

(iii) What is the relationship between the structures of **P** and **Q**?

(b) The molecular species **X** is more stable than the molecular species **Y**, structures shown below. Show how resonance theory can be used to explain this observation.

X: 

Y: 

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

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

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C 212: INTRODUCTION TO BIOCHEMISTRY

TIME: THREE HOURS

INSTRUCTIONS:

i) ANSWER ANY (5) FIVE QUESTIONS

ii) MAKE SURE YOU HAVE FOUR (4) PRINTED PAGES

QUESTION 1 a) Briefly **describe** the properties of metal ions make them useful cofactors.

b) In a typical experiment, a phenylalanine containing peptide was subjected to chymotrypsin treatment giving the following results:

[Peptide] (mM)	Rate (M /min) x 10^3
3.0	2.29
5.0	3.20
7.0	3.86
9.0	4.36
11.0	4.75

Using the Lineweaver-Burke plot, **calculate** the K_m and V_{max} for this enzymatic reaction. **[20 MARKS]**

QUESTION 2 a) The $\Delta G'^{o}$ for the reaction Citrate ⟶ Isocitrate is +1.59 cal.mol^{-1}. The $\Delta G'^{o}$ for the reaction Isocitrate ⟶ α-ketoglutarate is -63.9 kcal.mol^{-1}. **What** is the $\Delta G'^{o}$ for the conversion of citrate to α-ketoglutarate? **Is** the reaction exergonic or endergonic, and **why**?

b) Using information that you obtain in a) above, **determine** whether or not ATP can be synthesized from the conversion of citrate to α-ketoglutarate (hint: ATP hydrolysis to ADP yields $\Delta G'^{o}$ of -7.3 kcal.mol^{-1}). **Show** a calculation on which on you base you answer.

[20 MARKS]

QUESTION 3 If HA represents a weak acid,

a) **Write** an equation for its dissociation constant.
b) Use your answer in a) to **derive** the Henderson-Hasselbalch equation.
c) **What** is the pH of a buffer mixture of 5 mL of 0.1 mol/L sodium acetate and 4 mL of 0.1 mol/L acetic acid? (pKa for acetic acid = 4.76) Then **calculate** the pH after adding 1 mL of 0.01 mol/L sodium hydroxide to the buffer mixture.
d) From your answer in c) above, how can you **define** a buffer?
e) The major buffer systems in mammals are protein (HPr), bicarbonate ($H_2CO_3^-$) and H_3PO_4. **Show** the first the first dissociation for the protein and phosphate buffer systems.

[20 MARKS]

QUESTION 4 The separation of molecules from biological materials involves the isolation of one species from a mixture. With the help of simple diagrams, briefly **describe** the separation of a mixture:

a) containing large and small using gel filtration.
b) of two amino acids, one positively charge and the other negatively charged, using ion exchange chromatography with an anion exchanger.

c) of three amino acids (lysine, histidine and aspartic acid pH 7.6 when all the carboxyl and amino groups in all the amino acids are ionized) using paper electrophoresis.

Draw the tripeptide:

lysinylhistidinylaspartic acid at pH 7.6

[20 MARKS]

QUESTION 5 Biochemical macromolecules are formed by linking monomer units through different but specific tires of linkages.

a) **Design** a suitably headed table naming the four major macromolecules, their monor unit(s) and the names and types of linkages between them.

b) **Name** and **draw** the types of linkages between them.

c) **State** the three major structural differences between DNA and RNA.

d) The following data were collected on the structure of a nanopeptide chain: Total hydrolysis gave Gly, Pro_3, Phe_2, Ser, Arg_2. Treatment of the chain with 2,4-dinitrofluorobenzene followed by acid hydrolysis gave 2,4-dinitrophenylarginine; C-terminal analysis gave proline. Partial acid hydrolysis gave the following oligopeptides, among others Pro-Phe-Arg, Ser-Pro-Phe, Arg-Pro, Phe-Ser-Pro, Arg-Pro, Gly-Phe-Ser and Pro-Gly.

Give a structure for the nanopeptide chain consistent with data.

[20 MARKS]

QUESTION 6 Oleic acid ($18:1\Delta^9$) is a common unsaturated fatty acid in human foods.

a) **What** is the full meaning of the notation $18:1\Delta^9$?

b) **Draw** the common structure of oleic acid.

c) How can you **distinguish** between liquid oleic acid and liquid stearic acid, 18:0?

d) **Draw** the structure of glyceryl tristearate.

e) **Calculate** the saponification number of the fat glycerol tristearate (Atomic Mass H = 1.0, C = 12.0, O = 16.0, and K = 39.1).

[20 MARKS]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

C 225: ANALYTICAL CHEMISTRY 1
TIME: 3 HOURS

INSTRUCTIONS:

1. **THIS PAPER CONTAINS FIVE (05) QUESTIONS.**
2. **ANSWER ANY THREE (03) QUESTIONS.**
3. **EACH QUESTION CARRIES 20 MARKS.**
4. **SHOW ALL YOUR WORKING CLEARLY.**
5. **ESSENTIAL DATA TABLES ARE ATTACHED TO THE QUESTION PAPER.**

Question 1.

a. The determination of vitamin B_2 (Riboflavin) content in cereal samples is carried out by measuring fluorescence intensity in a 5% acetic acid solution. From analytical data given below:

Standards concentration (ppm): 0.000; 0.100; 0.200; 0.400; 0.800

Fluorescence intensities (I): 0.000; 5.8; 12.2; 22.3; 43.3

i). use the method of least squares to obtain the equation for the best-fit line

ii). calculate the concentration of riboflavin in a sample for which intensity was found to be 15.4

b. A solution contains 75.0 ppm of dissolved $NaNO_3$. Calculate the concentration of nitrate ions in the solution, giving your answer in ppb.

c.

i). Distinguish between the solubility and solubility product of silver chloride.

ii). Determine whether a precipitate will form if 10 mL of 0. 0.0001 M $AgNO_3$ is added to 90 mL of 0.000045 M NaCl (K_{sp} for AgCl = 1.0×10^{-10}).

Question 2.

a. Sodium was determined in water by flame photometry methodology; and, the results were as follows:

Standard solution (ppm):	1.0	2.0	3.0	4.0	5.0
Absorbance (A):	0.205	0.410	0.615	0.820	1.025

From the data obtained, determine the regression line and calculate the sodium concentration in the water sample if sample absorbance was 0.550 A.

i). determine the equation for the best-fit line for the calibration curve

ii). calculate the concentration of sodium in a sample for A was found to be 15.4

b. A solution contains 2.50×10^{-4} M Cu $(NO_3)_2$. Calculate the copper nitrate content of the solution, in ppm; and, the concentration of nitrate ions, giving your answer in ppb; given, that Cu $(NO_3)_2$ is a strong electrolyte.

Question 2.

c. The first and second acidity constants of H_2S are 10^{-7} and 10^{-15} respectively. Calculate:

i). the equilibrium constant (K_a) for the reaction $H_2S + 2H_2O \rightarrow 2H_3O^+ + S^{2-}$

ii). the concentration of S^{2-} ion in a 0.1 M H_2S solution at pH 2.

Question 3.

a. Citric acid is a triprotic organic acid, $HO(CH_2COOH)_3$, characterised by the following acid dissociation constants $pK_{a1} = 3.1296$; $pK_{a2} = 4.7570$ and $pK_{a3} = 5.3990$. Determine the equilibrium concentrations of the molecular acid and the citrate ion (without any protons) at equilibrium in a 0.500 M solution at pH 2.

b. Calculate the pH of a buffer solution prepared by adding 85 ml of 0.20 M acetic acid to 115 ml of 0.50 M sodium acetate; given that for acetic acid, the value of $K_a = 1.75 \times 10^{-5}$.

c.

i). Define the term 'detection limit'.

ii). Absorbance readings of a blank were made in a spectrophotometric method as follows: 0.002; 0.000; 0.006; 0.008; 0.003 and 0.000. A standard solution of 1ppm analyte solution gives an absorbance reading of 0.069. What is the detection limit for the method?

Question 4.

a. The zinc content of a soil sample was determined by two methods (AAS; and, colorimetry). The data obtained were as follows:

AAS (mg/dL) : 10.9, 10.1, 10.6, 11.2, 9.7, 10.0

Colorimetry (mg/dL): 9.2, 10.5, 9.7, 11.5, 11.6, 9.3, 9.3, 10.1, 11.2

Determine whether there is significant difference in the precision of the two methods at 95% confidence level.

b. What is the degree of hydrolysis and pH of a 0.10 M solution of sodium acetate, NaOAc? For acetic acid, HOAc, $K_a = 1.75 \times 10^{-5}$.

c. Determine whether a precipitate will form if 20 mL of 0.01M $AgNO_3$ is added to 80 mL of K_2CrO_4 (K_{sp} for $Ag_2CrO_4 = 1.7 \times 10^{-12}$)

Question 5.

a. During the manufacture of anti-diarrhoeal mixture, a set of bottles was weighed to determine if they fell within acceptable standard control guidelines. The individual bottle weights were: 127.2g; 128.4g; 127.1g; 129.0g and 131.1 g. Determine whether the last weight is an outlier datum at 99% CL.

b. Determine whether a precipitate will form if 0.05 mg $AgNO_3$ is added to 2.0 L of 0.0001 M NaCl (K_{sp} for AgCl = 1.0×10^{-10}).

c. What are the equilibrium concentrations of the hydrogen arsenate ion ($H_2AsO_4^-$) and its conjugate base at pH 3 in a 0.200 M arsenic acid, H_3AsO_4, solution whose dissociation constants for the successive ionisations are given as follows, $Ka_1 = 5.65 \times 10^{-3}$; $Ka_2 = 1.75 \times 10^{-7}$ and $Ka_3 = 2.54 \times 10^{-12}$.

END OF EXAMINATION

Universal Statistical Tables: **C 225 / C205 / CAV 251.**

1. Rejection Quotient, Q, at Different Confidence Limits.

Number of Observations	Confidence Level Q_{90}	Q_{95}	Q_{99}
3	0.941	0.970	0.004
4	0.765	0.829	0.926
5	0.642	0.710	0.821
6	0.560	0.625	0.740
7	0.507	0.568	0.680
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568
15	0.338	0.384	0.475
20	0.300	0.342	0.425
25	0.277	0.317	0.393
30	0.260	0.298	0.372

2. Values of t for v Degrees of Freedom at Different Confidence Limits.

Number of Degrees of Freedom	Confidence Level 90%	95%	99%	99.5%
1	6.314	12.706	63.657	127.320
2	2.920	4.303	9.925	14.089
3	2.353	3.182	5.841	7.453
4	2.132	2.776	4.604	5.598
5	2.015	2.571	4.032	4.773
6	1.943	2.441	3.707	4.317
7	1.895	2.365	3.500	4.029
8	1.860	2.306	3.355	3.832
9	1.833	2.262	3.250	3.690
10	1.812	2.228	3.169	3.581
15	1.753	2.131	2.947	3.252
20	1.725	2.086	2.845	3.153
25	1.708	2.060	2.787	3.078
Infinite	1.645	1.960	2.576	2.807

3. Values of F at the 95% Confidence Level

v_1 =		2	3	4	5	6	7	8	9	10	15	20	30
v_2 =	2	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.5
	3	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.70	8.66	8.62
	4	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.86	5.80	5.75
	5	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.62	4.56	4.50
	6	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	3.94	3.87	3.81
	7	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.51	3.44	3.38
	8	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.22	3.15	3.08
	9	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.01	2.94	2.86
	10	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.85	2.77	2.70
	15	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.40	2.33	2.25
	20	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.20	2.12	2.04
	30	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.01	1.93	1.84

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 27.99 Aluminium	14 Si 28.09 Silicon	15 P 30.99 Phosphorus	16 S 32.07 Sulphur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.88 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.65 Copper	30 Zn 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 71.61 Germanium	33 As 74.92 Arsenic	34 Se 78.96 selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc 97.91 Technetium	44 Ru 101.07 Ruthenium	45 Rh 102.91 Rhodium	46 Pd 106.42 Palladium	47 Ag 107.87 Silver	48 Cd 112.41 Cadmium	49 In 114.82 Inidum	50 Sn 118.71 Tin	51 Sb 121.76 Antimony	52 Te 127.60 telurium	53 I 126.90 Iodine	54 Xe 131.2 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 222.0 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	60 Nd 144.24 Neodymium	61 Pm 144.91 Promethium	62 Sm 150.36	63 Eu 151.97 Europium	64 Gd 157.25 Gadolinium	65 Tb 158.93 Terbium	66 Dy 162.50	67 Ho 164.93 Holmium	68 Er 167.26 Erbium	69 Tm 168.93 Thulium	70 Yb 173.04	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	95 Am 243.06	96 Cm 247.07 Curium	97 Bk 247.07	98 Cf 251.08	99 Es 252.08 Einstienium	100 Fm 257.10 Fermium	101 Md 260	102 No 259.10	103 Lr 262.11

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C 312: **BIOCHEMISTRY II**

TIME: **THREE HOURS**

INSTRUCTIONS:

i) **ANSWER ANY FIVE (5) QUESTIONS**

ii) **MAKE SURE YOU HAVE THREE (3) PRINTED PAGES**

QUESTION 1

a) *E. coli* DNA polymerase I is a complex enzyme. Briefly **describe** TWO of its activities and briefly **explain** their roles in DNA synthesis.

b) **Why** is a short RNA primer needed for DNA replication? Briefly **explain**.

c) Using the genetic code provided (Figure 1) **determine** the amino acid sequence of the following nucleotide. Assume the reading frame is shifted 2 bases to the right.

AATGGTAGGATTCCCCCCCGTGGATTCC

[20 MARKS]

QUESTION 2

a) **Draw** a neat and well labeled diagram showing the gene structure in the *lac operon*.

b) Briefly **explain** how *E. coli* represses the expression of the structure in a) above.

c) **What** is the function of catabolite activator protein (CAP) and **how** does it work?

[20 MARKS]

QUESTION 3

Cancer patients can be given cytotoxic (cell-killing) agents like FdUMP, a fluorine containing analogue of UMP and methotraxate to treat the disease. Unfortunately, these drugs cause patients to temporarily go bald.

a) **Show** by means of structures and reactions how these agents serve as cancer therapeutic agents.

b) **Briefly** explain why these patients go bald.

[20 MARKS]

QUESTION 4

Excretion of nitrogen is one of the key functions of the liver. **Describe** how this process is carried out in man and **explain** how it is linked to the metabolism of proteins.

[20 MARKS]

QUESTION 5

Describe the degradation of a fatty acid with the structure **17:2**$^{\Delta 9,12}$ and **explain** how much energy is produced in the form of ATP.

[20 MARKS]

QUESTION 6

Describe the formation of glucose in C4 plants, clearly explaining the role of the products of the light-dependent reactions.

[20 MARKS]

END OF EXAMINATION

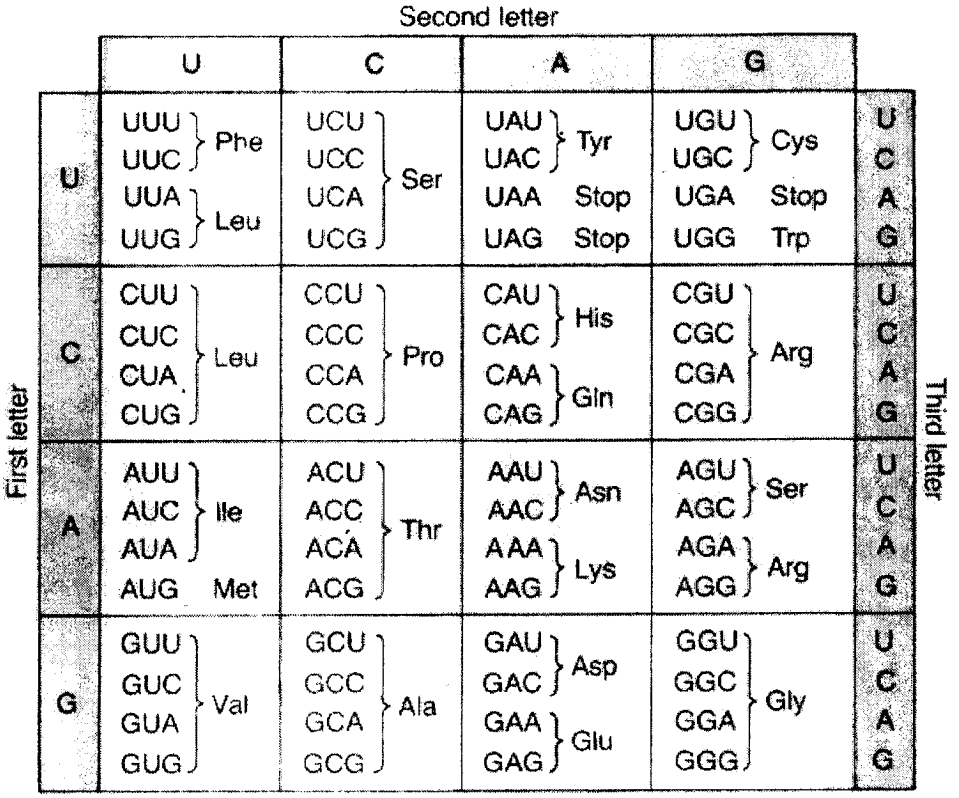


Figure 1 **Genetic code**

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

C322 ANALYTICAL CHEMISTRY III

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: Answer **all** the questions in this paper.

---

1 Explain the principle(s) of Coulometric Method.

2 Explain differences between classical and pulse polarography methods.

3 Describe the Van Deemter equation. Draw it and explain each part of it.

4 The retention time of an organic peak was 24seconds. Calculate the height equivalent of a theoretical plate for the column.

5 A 1.955g of iodized salt was dissolved in water (H_2O) and electrolyzed at +0.72V vs SCE to oxidize I^- to I_2. A charge of 257mC passes before the current reaches its residual current value is 15μA. electrolysis time was 70 minutes. Calculate the percentage of KI in the salt sample.

6 Calculate the nitrobenzene in 210mg of an organic mixture that was reduced to phenylhydroxylamine at a constant potential of -0.96V (versus SCE) applied to a mercury cathode.

$$C_6H_5NO_2 + 4H^+ + 4e \longrightarrow C_6H_5NHOH + H_2O$$

The sample was dissolved in 100ml of methanol after electrolysis for 30 minutes, reaction was judged complete. An electronic coulometer in series with the cell indicated that the reduction required 26.74C. Calculate the percentage of $C_6H_5NO_2$ in the sample.

7 At a potential of -1.0V (versus SCE), CCl_4 in methanol is reduced to $CHCl_3$ at a mercury cathode.

$$2CCl_4 + 2H^+ + 2e + Hg(I) \longrightarrow 2CHCl_3 + Hg_2Cl_2$$

At -1.80V, the $CHCl_3$, further reacts to give CH_4.

$$2CHCl_3 + 6H^+ + 6e + 6Hg(I) \longrightarrow 2CH_4 + 3Hg_2Cl_2\ (s)$$

A 0.750g sample containing CCl_4, $CHCl_3$ and inert organic species was dissolved in methanol and electrolyzed at -1.0V until the current approached zero. A coulometer indicated 11.63C was required to complete the reaction. The potential of the cathode was adjusted to -1.8V. Completion of the titration at this potential required an additional 68.6C. Calculate the percentage of CCl_4 and $CHCl_3$ in the mixture.
(MM CCl_4 = 153.823; $CHCl_3$ = 119.31)

8 Explain DME, limiting current and diffusion current. ~~Describe differences between classical and pulse polarography.~~

9 What is the relative decrease of concentration of lead ions in percent after electrolysis on the DME, which lasted 10 minutes? Suppose that current was throughout the electrolysis constant. 200 drops was fall down from capillary after 20 minutes, which weight 2.400g. Diffusion coefficient was, $D = 0.9 \times 10^{-5} cm^2 s^{-1}$ and concentration was $3 mmol L^{-1}$ and the volume in the bulk was V = 20ml.

10 The following data apply to a column for liquid chromatography.

Length of packing	24.7cm
Flow rate	0.313ml/min
Vm	1.37ml
Vs	0.164ml

A chromatogram of mixture of species A, B, C and D provided the following:

Species	Retention time, Minutes	Width peak base (W), Minutes
Non retained	3.1	-
A	5.4	0.41
B	13.3	1.07
C	14.1	1.16
D	21.6	1.72

Calculate:

(a) The number of plates from each peak

(b) The mean and the potential deviation for N

(c) Plate height for the column.

11 (a) From the data in problem 10 for A, B, C, and D calculate:

(i) The capacity factor
(ii) The partition coefficient

(b) From the data in problem 10 for B and C calculate

(i) the resolution
(ii) the selectivity factor d
(iii) the length necessary to give resolution of 1.5
(iv) the time required to separate B and C with a resolution of 1.5

(c) From the data in problem 10 for species C and D, calculate the
(i) Resolution

(ii) Length of column required to give a resolution of 1.5

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

C352: ORGANIC CHEMISTRY IV

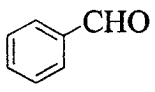
TIME: THREE HOURS

INSTRUCTIONS:

1. Answer any **FOUR** Questions.
2. Present your Answers in a Logical Manner.
3. Mark Allocation for Questions is Shown, (x)

QUESTION ONE

(a) When Knoevenagel condensations are run in pyridine solution, decarboxylation usually occurs in the reaction mixture, leading to formation of α, β-unsaturated compounds. On this basis, predict the structure of the product, including pertinent stereochemistry, and give mechanism of the following reaction:



$$+\ CH_3CH(COOH)_2 \xrightarrow[\text{pyrrolidine}]{\text{piperidine}} C_{10}H_{10}O_2$$

$\triangle$

[12]

(b) Deduce the structure of the spiro compound **G** from the following synthesis. Show the structures of all intermediates, **A – F, in** this synthesis.

$$NaCH(COOEt)_2 + BrCH_2CH_2Br \longrightarrow \mathbf{A} \xrightarrow[Me_3COH]{Me_3COK} \mathbf{B},\ C_{10}H_{16}O_4$$

$$\mathbf{B} \xrightarrow[(ii)\ H_2O]{(i)\ LiAlH_4,\ \text{dry ether}} \mathbf{C},\ C_6H_{12}O_2 \xrightarrow{HBr} \mathbf{D},\ C_6H_{10}Br_2$$

$$\mathbf{D} \xrightarrow[2,\text{moles NaOEt}]{CH_2(COOEt)_2} \mathbf{E},\ C_{13}H_{20}O_4 \xrightarrow[(ii)\ H_3O^+]{(i)\ \text{aq. NaOH},\ \triangle} \mathbf{F},\ C_9H_{12}O_4 \longrightarrow \mathbf{G},\ C_8H_{12}O_2$$

[12]

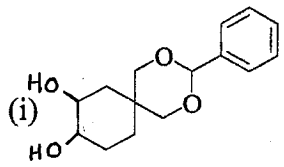
(c) Why is aniline, $PhNH_2$ ($K_b = 4.2 \times 10^{-10}$), less basic than pyridine ($Kb = 2.3 \times 10^{-9}$)

[6]

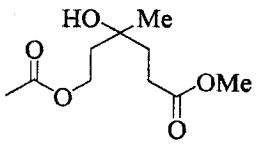
QUESTION TWO

(a) Using the disconnection approach, propose an efficient synthesis of **any two** of the following compounds from readily available starting materials and reagents. Show the reagents, the solvents, if any, and the reaction conditions for each step of your proposed synthesis.

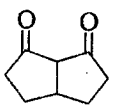
(i)



(ii)

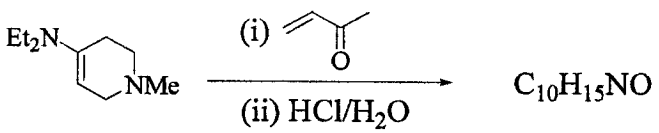


(iii)



[20]

(b) Identify the products and give mechanisms of the following reactions:

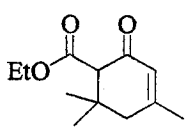


[20]

QUESTION THREE

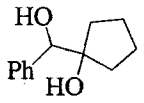
(a) When mesityl oxide, $(CH_3)_2C{=}CHCOCH_3$, is reacted with acetoacetic ester and potassium tertiary-butoxide, a product **H**, structure shown below, is isolated in good yield. Provide a mechanistic explanation to account for the observed product of this reaction.

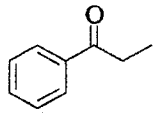
Compound H:



[11]

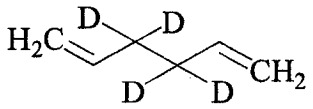
(b) Predict the products and give mechanisms of the following reactions:

(i)  $\xrightarrow{H_2SO_4}$?

(ii)  $\xrightarrow[\text{(ii) PPA, } \triangle]{\text{(i) } H_2NOH.HCl}$?

[14]

(c) When the deuterated 1,5-hexadiene, **X**, structure shown below, is exposed to ultra-violet radiation, a photochemical isomerisation takes place. Suggest the most likely structure of the product and give the mechanisms of the reactions involved in the isomerisation.



X: 1,5-hexadiene

QUESTION FOUR

(a) Give the expected product of the Vilsmeier formylation of pyridine-N-oxide and explain the orientation. Name the substituted benzene analogy that is electronically similar to pyridine-N-oxide.

[10]

(b) Predict the products and give mechanisms of the following reactions:

(i) Thiophene $\xrightarrow{Br_2/\text{benzene}}$? (a dibrominated product)

(ii) Furan $\xrightarrow{CH_3CONO_2}$?

[12]

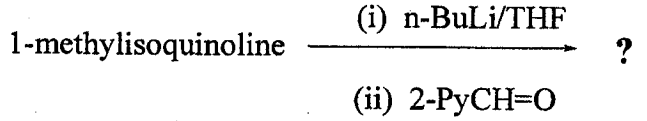
(c) Compare the acidities of the methyl hydrogens of 2-methyl- and 4-methyl-pyridines with those of 3-methylpyridine.

[8]

QUESTION FIVE

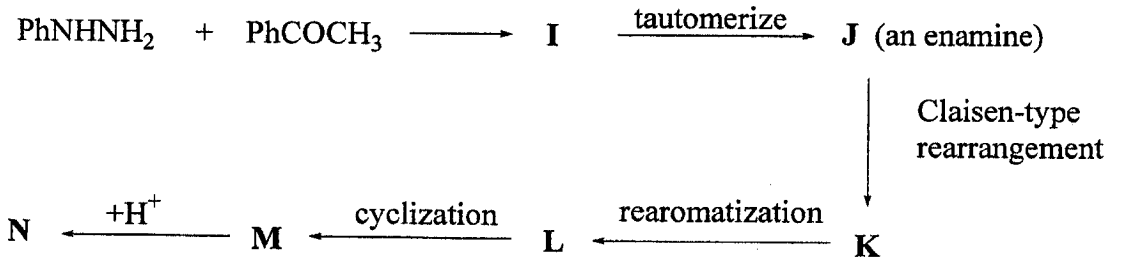
(a) (i) Explain the differences in behaviour when 1- and 3-methylisoquinolines are treated with n-BuLi.

(ii) Identify the product of the following reaction:



[10]

(b) The Fischer indole synthesis starts with an arylhydrazone and utilizes Bronsted-Lawry or Lewis acid, such as $ZnCl_2$. Provide the structural formulas for the intermediates **I** through **M**, involved in the following synthesis of 2-phenylindole, **N**.



[14]

(c) Give the structure of the phenylhydrazone needed to synthesize 3-ethyl-2methyl-5-phenylindole by the Fischer method and show the isomeric product that is also obtained.

[6]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER

FINAL EXAMINATIONS

C 412: ADVANCED BIOCHEMISTRY II

TIME: THREE HOURS

INSTRUCTIONS:

i) ANSWER ANY FOUR (4) QUESTIONS

ii) MAKE SURE YOU HAVE THREE (3) PRINTED PAGES

QUESTION 1

a) **Distinguish** between:
   i) A restriction enzyme and pancreatic DNase
   ii) Genomic clone and cDNA clone
   iii) Sticky ends and blunt ends
   iv) PCR primer and a hybridization probe

b) Sometimes knowing the DNA sequence of a gene that codes for a protein does not tell you the amino acid sequence. **Suggest** several reasons why this is so.

[20 MARKS]

QUESTION 2

Discuss in detail (maximum 1 page) a method you would use to produce human growth hormone in *E. coli.*

[20 MARKS]

QUESTION 3

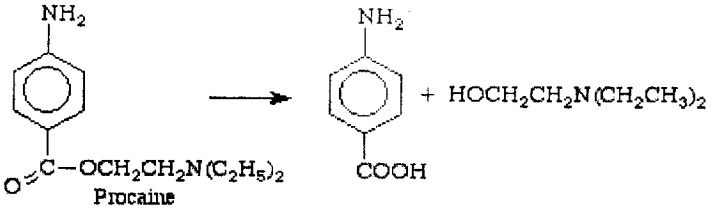
Describe in detail:

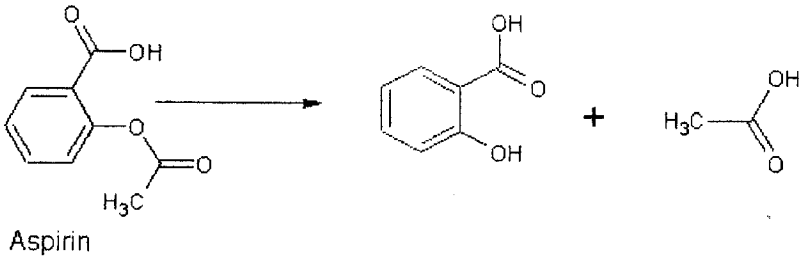
a) the steps involved in the production of milk powder.
b) difference between milk fortification and milk tainting giving clearly explained examples of each.

[20 MARKS]

QUESTION 4

Procaine, a compound used as a local anesthetic and aspirin (acetyl salicylic acid), were transformed to ρ-amino benzoic acid (PABA) and salicylic acid respectively as shown in Figure 1.





Aspirin

Figure 1 **Procaine and aspirin biotransformation reactions**

a) **Describe** the mechanism(s) used to biotransform the two compounds to their respective products (shown in figure 1) and **explain** the purpose of this transformation.

b) With the help of equations, **describe** in detail three phase II reactions each of the two products is capable of undergoing.

c) If procaine and aspirin were lipophilic and also capable of binding to some plasma proteins, **explain** in detail how these two factors would affect their rate of biotransformation.

d) **How** would the biotransformation of benzene differ from the mechanism(s) you have outlined in a) above. **Show** equations where possible.

[20 MARKS]

QUESTION 5

When a healthy vertebrate is invaded by a disease-causing agent the activated immune system produces reactive cells and proteins as a principal means of defense.

a) **Name** the main reactive cells and proteins and briefly outline their roles.

b) **Describe** the detailed structure of the immunoglobulins, IgG and estimate the molecular weight of one molecule of IgG. **Show** all the assumptions and calculations you make to arrive at your answer.

c) **Sketch** the kinetics of IgG appearance in the serum following a first and second exposure to the same disease-causing agent and briefly **explain** the sketch.

d) Class I and II major histocompatibility complex (MHC) molecules account for tissue or organ graft rejection. **Explain** the involvement of these molecules in graft rejection.

[20 MARKS]

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

C452: ADVANCED ORGANIC CHEMISTRY II

TIME: **THREE HOURS**

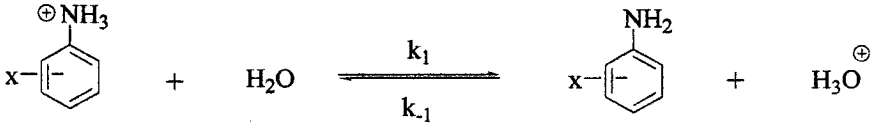
INSTRUCTIONS:

1. Answer ANY FOUR Questions.
2. Present your answers in a logical manner.
3. All questions carry equal marks (30).
4. Physical constants and expressions are given on page 6.

Max. Marks: 120

QUESTION ONE

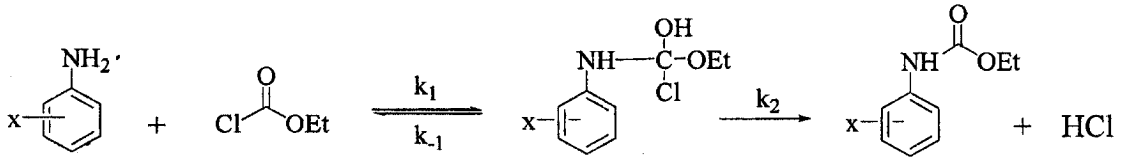
The calculated **ρ**-value for dissociation of anilinium ions at 25 ^{0}C is 2.77. The reaction is shown below:



(a) Using the calculated **ρ**-value for the above reaction, compute the log ratio of the ionization constants of **p**-nitroanilinium and unsubstituted anilinium ions.

(b) Laboratory experiments, however, have shown that the observed **ρ**-value of the above reaction is in fact 3.52 and **not** 2.77, a discrepancy well outside the experimental error, implying an effective **σ**-value of 1.77 for **p**-NO_2 substituent. Explain briefly this observation.

(c) A Hammett plot for the rate constants of the reaction shown below has a **ρ**-value of (-) 5.56 when substituent **x** is **p**-OCH_3, **p**-CH_3, **m**-CH_3 and H and using the **σ**-values of these substituents.



The same reaction has a **ρ**-value of - 1.57 when the substituent **x** is **p**-Br, m-Cl, **m**-NO_2, **p**-COOEt and **p**-NO_2 and using the **σ**-values of these substituents. Provide a mechanistic explanation for the difference in the observed values of **ρ** for the above reaction.

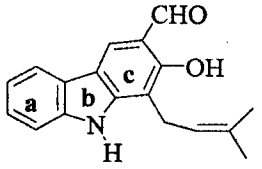
[30]

QUESTION TWO

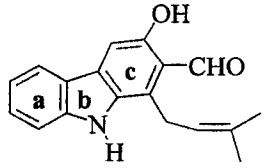
(a) From the spectral data (MS, UV, IR and ^{1}H-NMR spectra), two structures, **(I)** and **(II)** shown below, were proposed for the alkaloid, **A**, $C_{18}H_{17}NO_2$, isolated from the roots of a certain plant.

Proposed structures for the alkaloid A:

(I):

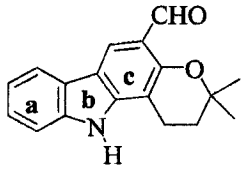


(II):



The structure of the alkaloid **A** was determined by studying its reaction with strong proton acids which revealed the positions of substituents on the benzene ring **c**. Upon refluxing with polyphosphoric acid, the alkaloid **A** gave an isomeric compound **B**, $C_{18}H_{17}NO_2$, structure shown below.

Compound B:



The UV spectra of compounds **A** and **B** were identical. The IR spectrum of **B** was similar to that of **A**, *except* for the carbonyl absorption band of **A** at 1645 cm^{-1}, which shifted to 1670 cm^{-1} in **B**. The 1H-NMR data for the compounds **A** and **B** are given below:

Compound A: ^{1}**H-NMR ($CDCl_3$), δ (ppm):**	**Compound B:** ^{1}**H-NMR ($CDCl_3$), δ (ppm):**
*11.6 (s, 1H); *11.4 (s, 1H); 9.9 (s, 1H); 8.25 (s, 1H); 8.3 – 7.1 (m, 4H); 5.35 (t, broad, 1H, J = 6 Hz); 3.6 (d, 2H, J= 6 Hz); 1.83 (d, 3H, J= 1 Hz); 1.66 (d, 3H, J = 1 Hz) * means the NMR peak disappeared upon deuteration.	*11.6 (s, 1H); 9.9 (s, 1H); 8.25 (s, 1H); 8.3 – 7.1 (m, 4H); 2.95 (t, 2H, J = 7.5 Hz); 2.0 (t, 2H, J = 7.5 Hz); 1.42 (s, 6H) * means the NMR peak disappeared upon deuteration.

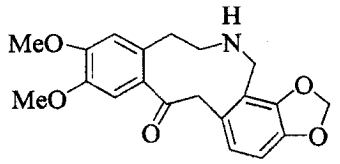
(i) Which of the proposed structures for the alkaloid **A** is consistent with the above findings? Explain your logic, including assignment of the NMR data.

(ii) Suggest the mechanisms for the reactions involved in the formation of **B** from **A**.

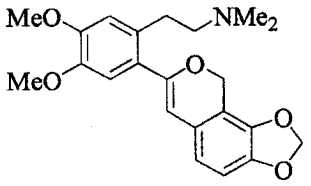
[16]

(b) Attempted Hofmann degradation of the alkaloid **C** gave an *unanticipated* product **D**, structures shown below, in good yield.

C:



D:



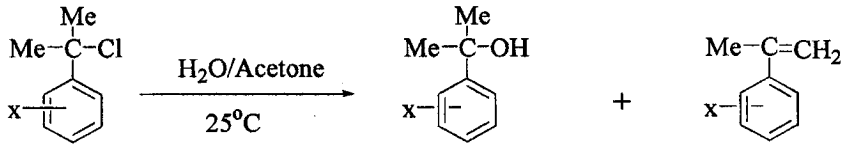
(i) Suggest plausible reaction mechanisms to account for the formation of the observed product **D**.

(ii) Predict the product when the alkaloid **C** is refluxed with phohsphoryl chloride ($POCl_3$).

[14]

QUESTION THREE

(a) The rate constants for SN1 hydrolysis of substituted phenyldimethylcarbinyl chlorides, shown below, in 90 % aqueous acetone at 25 ^{0}C are given in the Table below.



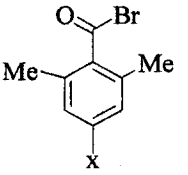
Substituent x	Rate 10^5 ks^{-1}	Substituent x	Rate 10^5 ks^{-1}
H	12.4	**p**- COOET	0.0806
m- OCH_3	7.56	**p**- CN	0.0126
m- CH_3	24.8	**m**- CN	0.0347
p- CH_3	322	**m**- NO_2	0.0108
p- Br	0.178	**p**- NO_2	0.00319

Draw the Hammett plot graph to show that the reaction correlates with σ^+ and comment briefly on the structure and stability of the transition state.

[14]

(b) In a study of the hydrolysis of **p**-substituted 2,6-dimethylbenzoyl bromides, structure shown below, in aqueous acetonitrile, a neutral solvent system, a **ρ** of (+) 1.20 for the

***p*-substituted-2,5-dimethylbenzoyl bromide:**



reaction was obtained from a Hammett **σ**- plot. When the hydrolysis was conducted in the same solvent in presence of an acid, a **ρ** of (–) 3.90 was found. Provide a mechanistic explanation for this observation.

[16]

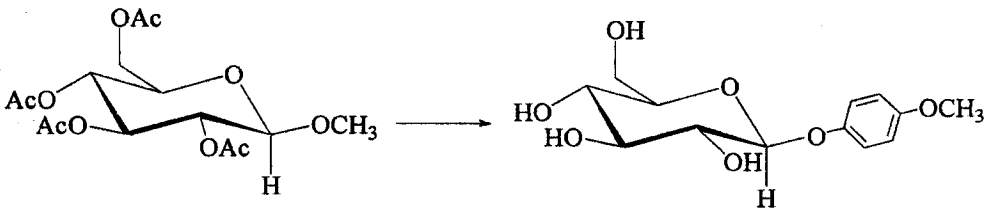
QUESTION FOUR

(a) Explain why:

(i) Free sugars are difficult to work with in the lab.
(ii) D-glucopyranoside does not undergo oxidation reaction.

[8]

(b) (i) Suggest a sequence of reactions for carrying out the following transformation in good yield. Show the reagents, the reaction conditions and the products for each step of your proposal.



(ii) Give the steps involved in the conversion of a D-aldopentose into a D-aldohexose. Illustrate your answer with a suitable example.

[14]

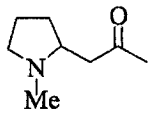
(c) Predict the product from the reaction of β-D-mannopyranose with phenylhydrazine and give the reaction mechanism.

[8]

QUESTION FIVE

(a) Isotopic labeling experiments suggest that in plants, the alkaloid **E**, structure shown below, is derived from the amino acid ornithine, $H_2N\text{-}CH_2CH_2CH_2CH(NH_2)\text{-}COOH$, and acetoacetyl coenzyme-A. On this basis propose a plausible biogenetic pathway for the alkaloid **E**.

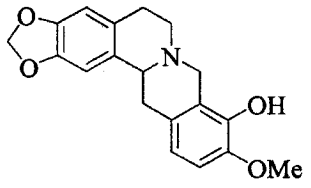
Alkaloid E:



[8]

(b) Using disconnection approach, devise a synthesis of the alkaloid **F**, structure shown below, from readily available non-heterocyclic starting materials and reagents. Show the reagents, including solvents, the reaction conditions and the product(s) for each step of your proposed synthesis.

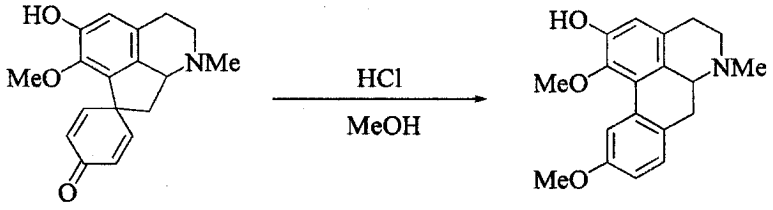
Alkaloid F:



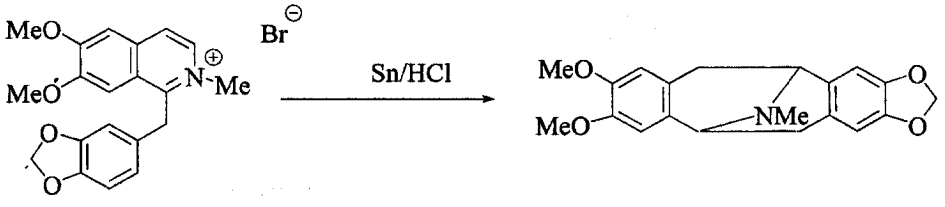
[12

(a) Most alkaloids are sensitive to acids and bases. Based on your understanding of the acid / base catalysed molecular rearrangements, suggest plausible reaction mechanisms to account for the indicated products of the following reactions:

(i)



(ii)



[10]

USEFUL DATA/INFORMATION

1. Physical Constants and Expressions:

(a) Physical Constants:

Substituent	σ	σ^-	σ^+
H	0.00	-	0.00
p- NO2	0.78	1.27	0.79
m- NO2	0.71	-	0.67
m- CH3	- 0.07	-	- 0.07
p- CH3	- 0.17	- 0.17	- 0.31
m- Br	0.39	-	-
p- Br	0.23	-	-
m- Cl	0.37	-	-
m- COOEt	0.37	-	-
p- OCH3	- 0.27	- 0.27	-
p- COOEt	- 0.45	0.68	0.48
m- OCH3	-	-	0.05
p- CN	-	-	0.66
m- CN	-	-	0.56

(b) Expressions:

$\log k/k_0 = \rho\sigma$ $\qquad$ $\log k = \rho\sigma + \log k_0$

$\log K/K_0 = \rho\sigma$ $\qquad$ $\log K = \rho\sigma + \log K_0$

$\log k/k_0 = -4.54\sigma^+$ $\qquad$ $\log k = -4.54\sigma^+ + \log k_0$

(c) ^{1}H-NMR Correlation

(i) Refer to Correlation Tables provided

(ii) Note that in the ^{1}H-NMR spectra of a compound, the NMR peasks for the protons on the hetero- atoms, such as **N, O, S,** disappear upon deuteration of the compound.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

C482: INORGANIC INDUSTRIAL CHEMISTRY

TIME: THREE HOURS

INSTRUCTIONS: ANSWER ANY FOUR QUESTIONS

Question 1.

(a) Describe the methods production of Ammonium sulphate.

(b) State the Frasch method, used for production of liquid Sulphur and sodium chloride brine. (Flow-sheet is attached).

(c) Briefly explain how orto- Phosphoric acid is produced by wet-method.

(d) How to determine the concentrations of H_3PO_4 and remains of Suphuric acid in the above indicated resulting product.

Question 2.

(a) Describe the two stage methane gas reforming process (include de-sulphurisation and 'shift' reactions).

(b) In the production of Nitric acid, Ammonia is mostly used. Outline physicochemical foundation manufacturing dilute Nitric acid.

(c) Describe the production process of dilute nitric acid (write down the temperatures, pressures and concentrations of the main components in the liquid and gaseous phases on the given flow sheet).

(d) Write down the use of concentrated and dilute Nitric acids, give reactions.

Question 3.

(a) Write down the physicochemical foundation manufacturing synthetic Ammonia.

(b) State the main two equipment of the synthetic Ammonia process: synthesis and condensation columns (sketches are attached) and indicate the flows by errors.

(c) Write down the use of the synthetic Ammonia, give reactions.

(d) Describe the production processes of Soda ash and sodium bicarbonate.

Question 4.

In the production of Sulphuric acid Iron pyrite, Sulphur and Hydrogen sulphide are usually used.

(a) What are the advantages and disadvantages associated with the use of these raw materials?

(b) Describe the SO_2 oxidation to SO_3 process (indicate kindling and other temperatures if Vanadium catalyst is used).

(c) State the properties of 98.3% sulphuric acid and why this acid is used for absorption of SO_3 containing gas?

(d) Write down the use of concentrated and dilute sulphuric acids, give reactions.

Question 5.

Write down the reactions and outline the major steps involved in the production of:

(a) Ammonium nitrate.

(b) Urea.

(c) Superphosphate.

(d) Hydrochloric acid.

END OF EXAMINATION

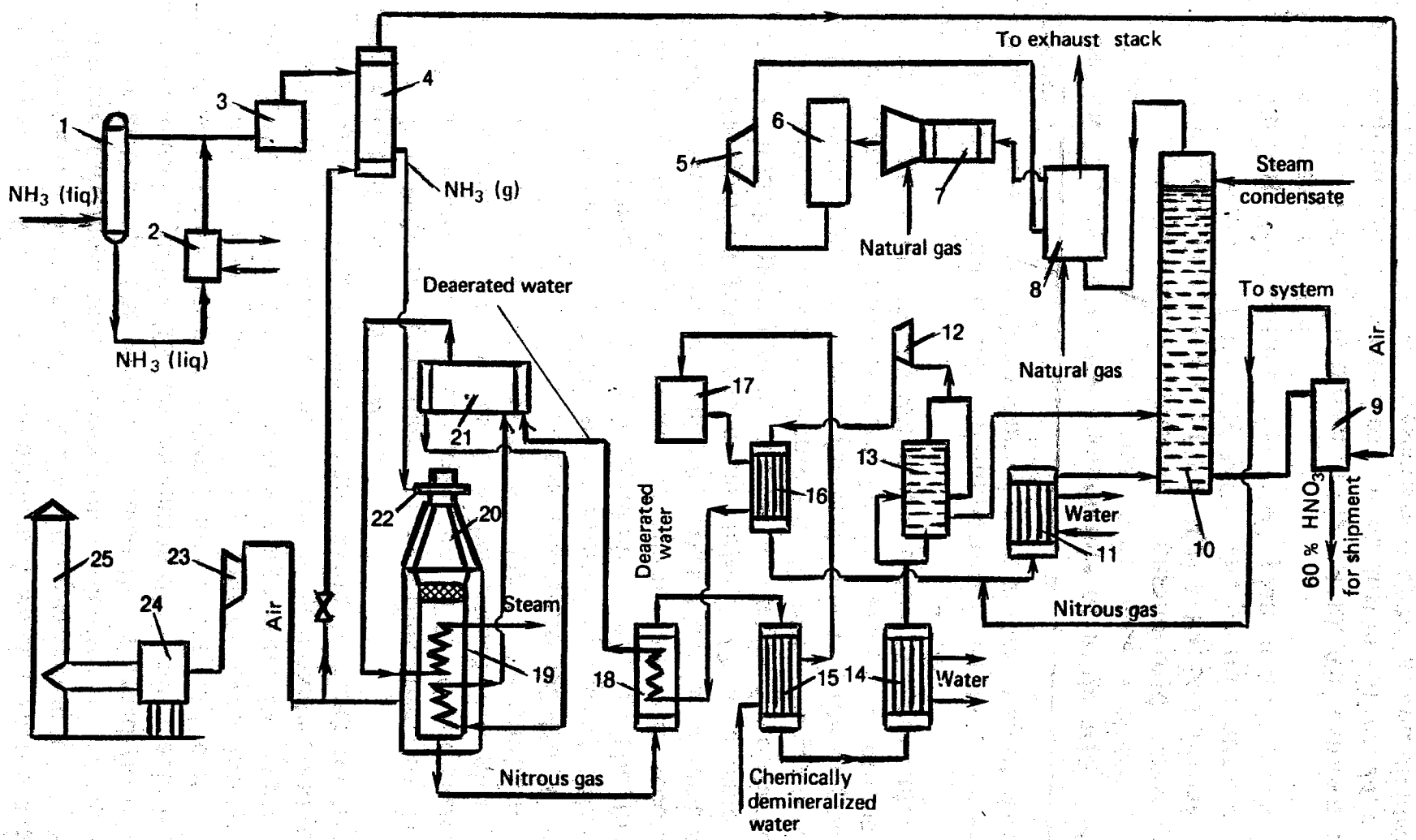
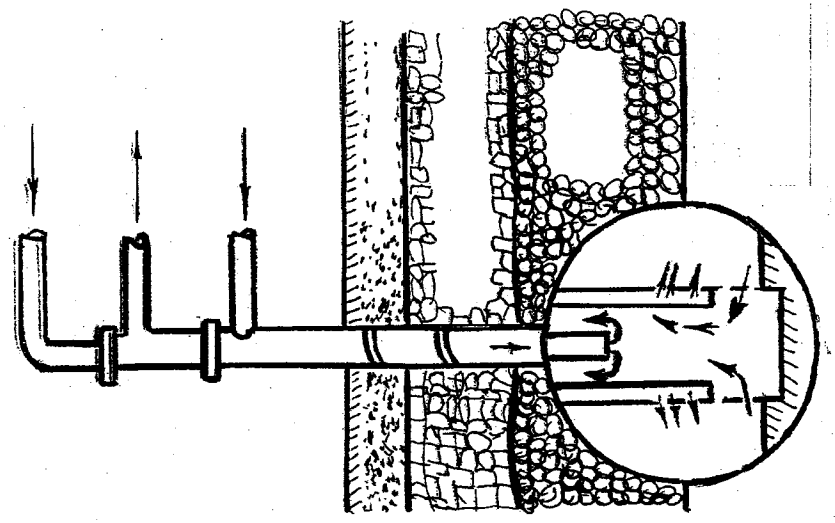


Fig. Process flowsheet of the AK-72 nitric acid plant:
1, receiver; *2*, vaporizer; *3*, filter; *4*, ammonia preheater; *5*, power-recovery turbine; *6*, catalytic scrubbing unit; *7*, mixer; *8*, combustor; *9*, bleaching tower; *10*, absorption tower; *11*, water cooler; *12*, air compressor; *13*, gas scrubber; *14*, water cooler; *15*, preheater; *16*, heat exchanger; *17*, deaeration tower; *18*, economizer; *19*, waste-heat boiler; *20*, converter; *21*, drum separator; *22*, mixing chamber; *23*, air compressor: *24*, filter; *25*, air-scoop funnel

Flow-sheet manufacturing sulphur
by Frasch method



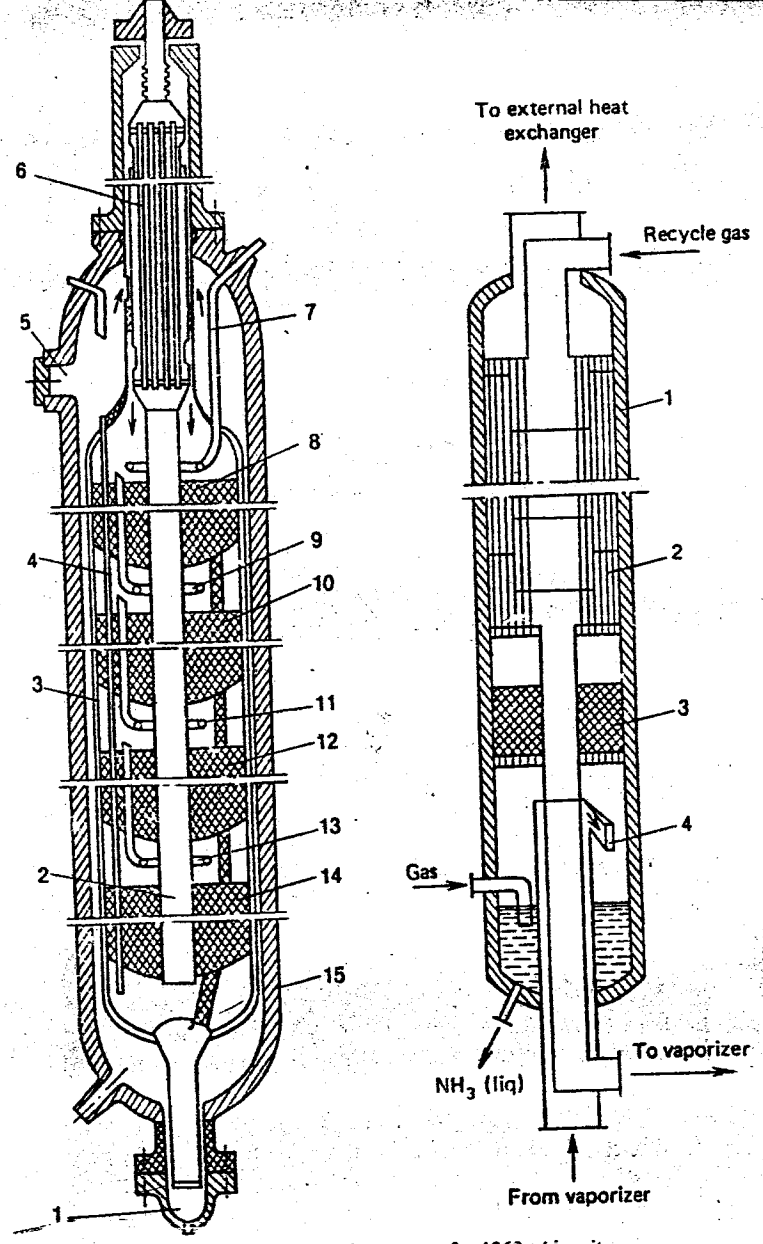


Fig. Four-stage ammonia synthesis reactor of a 1360 t/d unit:
1, catalyst discharge port; *2*, central pipe; *3*, catalyst box shell; *4*, thermocouple jacket; *5*, charging port; *6*, heat exchanger; *7*, bypass gas inlet; *8*, catalyst bed; *9*, bypass gas inlet; *10*, catalyst bed; *11*, bypass gas inlet; *12*, catalyst bed; *13*, bypass gas inlet; *14*, catalyst bed; *15*, reactor shell

Fig. Condensation tower:
1, shell; *2*, heat exchanger; *3*, spray catcher; *4*, separator

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

CS2032: COMPUTER ARCHITECTURE

SEMESTER 2 EXAM **5th MAY 2010**

TIME: THREE HOURS

ANSWER: ALL QUESTIONS IN SECTION (A) AND ANY FOUR (4) FROM SECTION (B)

SECTION A (ANSWER ALL QUESTIONS)

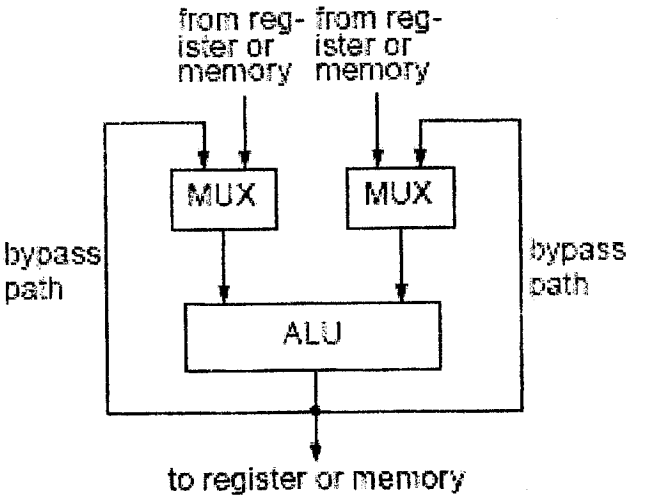
QUESTION 1

Describe the following:

(i) Synchronous – transmission [2 Marks]
(ii) Polling [2 Marks]
(iii) Structural hazards [2 Marks]
(iv) Data hazards [2 Marks]
(v) Control hazards [2 Marks]

QUESTION 2

(i) Identify the hazard avoided by the technique shown below. [1 Marks]
(ii) Describe this technique. [2 Marks]



QUESTION 3

Describe the effect of the following Cache Parameters on Performance.

(i) Larger cache size. [3 Marks]
(ii) Higher associativity. [3 Marks]
(ii) Larger block size. [3 Marks]

QUESTION 4

How can you reduce the following parameters to improve performance:

(i) Hit time. [1 Marks]
(ii) Miss rate [1 Marks]

(ii) Miss penalty [1 Marks]

QUESTION 5

There are basically two categories of printers in accordance with the printing technology. These are impact and non-impact printers. An inkjet printer falls in the category of non-impact printers.

(i) What are the two principles used in designing a multilevel cache? [2 Marks]

(ii) Define the following: Local miss rate, Global miss rate, Misses per instruction [3 Marks]

SECTION B ANSWER ANY FOUR (4) QUESTIONS

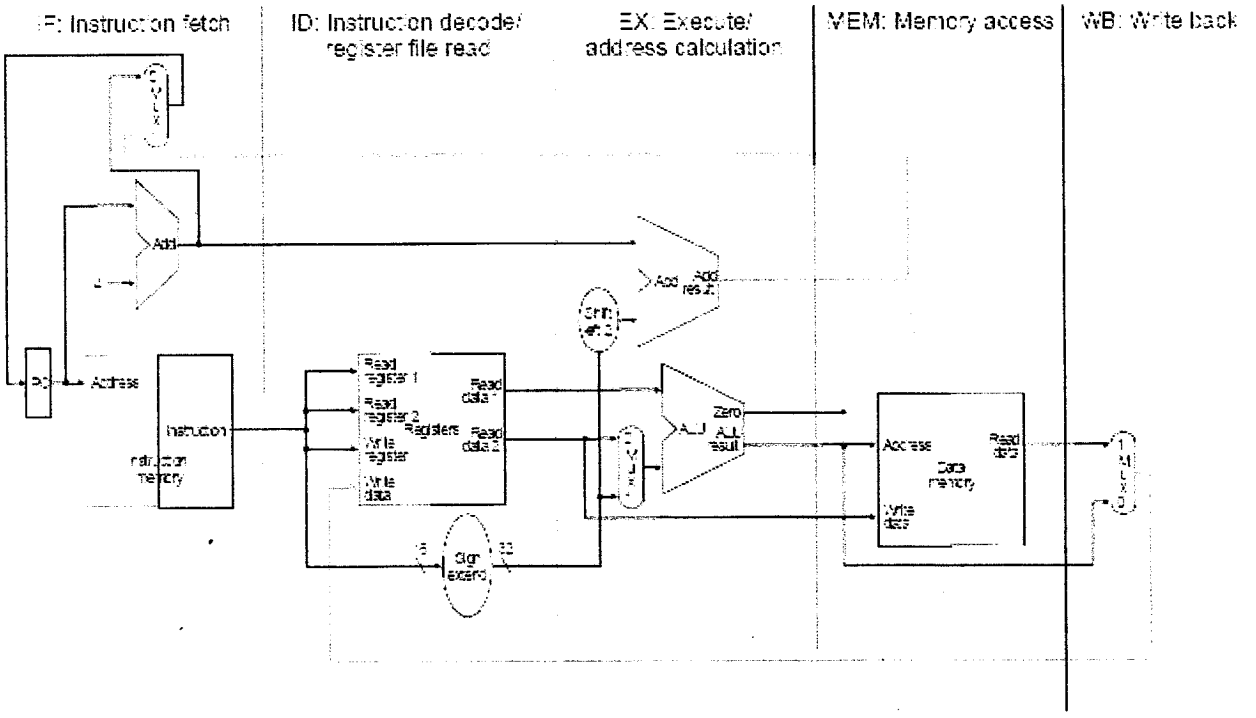
QUESTION 1

Build a 1bit ALU with a zero (0) carryin input [10 Marks]

QUESTION 2

Using the data path diagram shown below, describe in details the stages of executing the following instruction.

(i) lw $20, $10 [10 Marks]

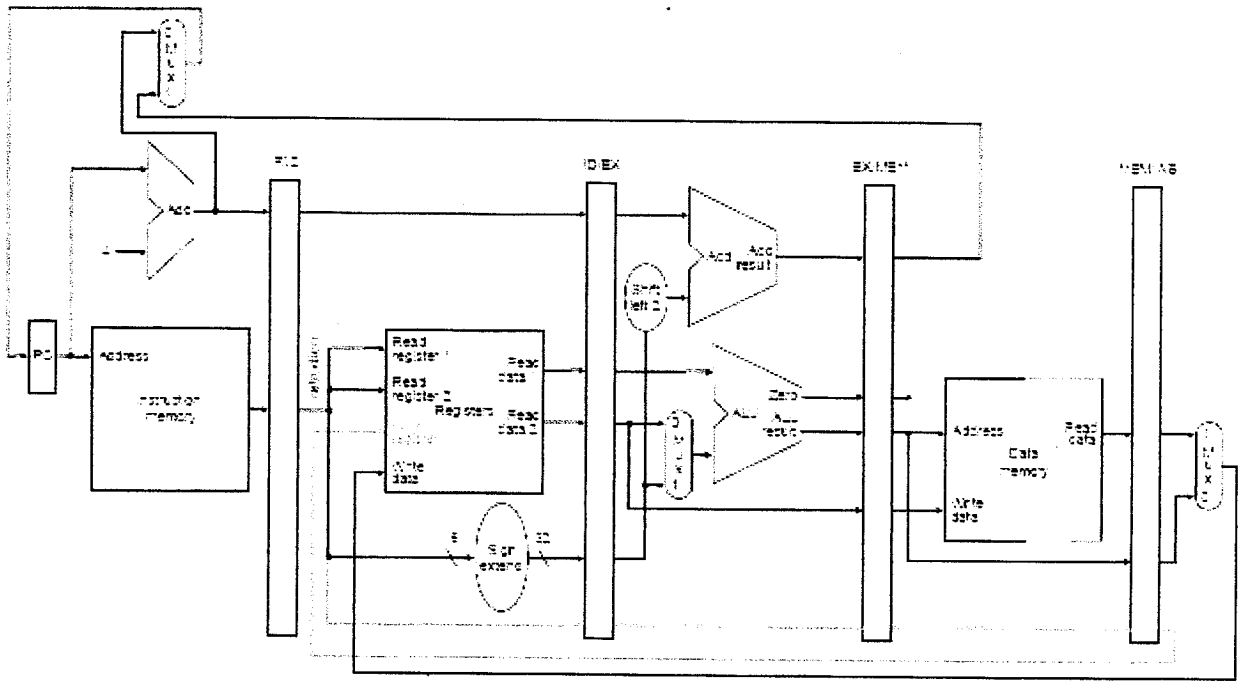


QUESTION 3

By way of shedding, using the data path diagrams, describe the stages of pipelining the following instructions (a pipeline datapath is shown below).

(i) lw $20, $10 [5 Marks]

(ii) sw $20, $10 [5 Marks]



QUESTION 4

(i) Describe the four step protocol of operation when a victim cache is incorporated in a multilevel cache system [4 Marks]

Define the Inclusion Policy on the following:

(ii) Inclusive multilevel cache, [3 Marks]

(iii)Exclusive multilevel caches, [3 Marks]

QUESTION 5

Describe the three types of Placement Policy in a cache [10 Marks]

END OF EXAM

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

CS3252: ELECTRONICS FOR COMPUTING II

SEMESTER 2 EXAM **27th APRIL 2010**

TIME: THREE HOURS

ANSWER: ANY FIVE QUESTIONS

QUESTION 1

Determine the output of the DAC in figure 1(a) if the sequence of 4-bit numbers in part (b) is applied to the inputs. The data inputs have a low value of 0v and a high value of +5v. [12 Marks]

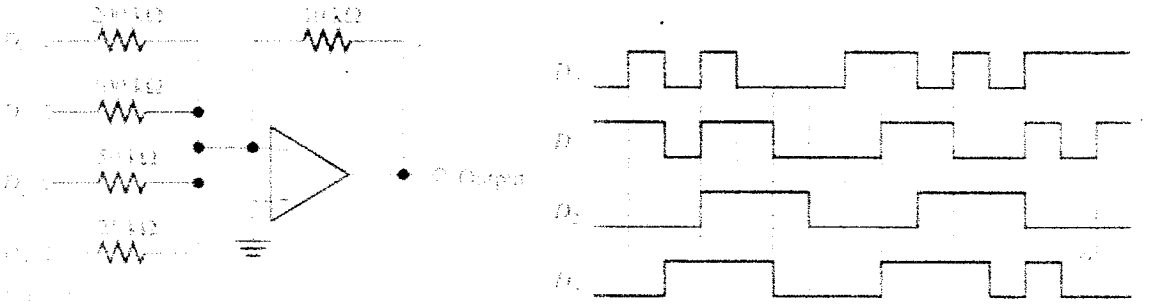
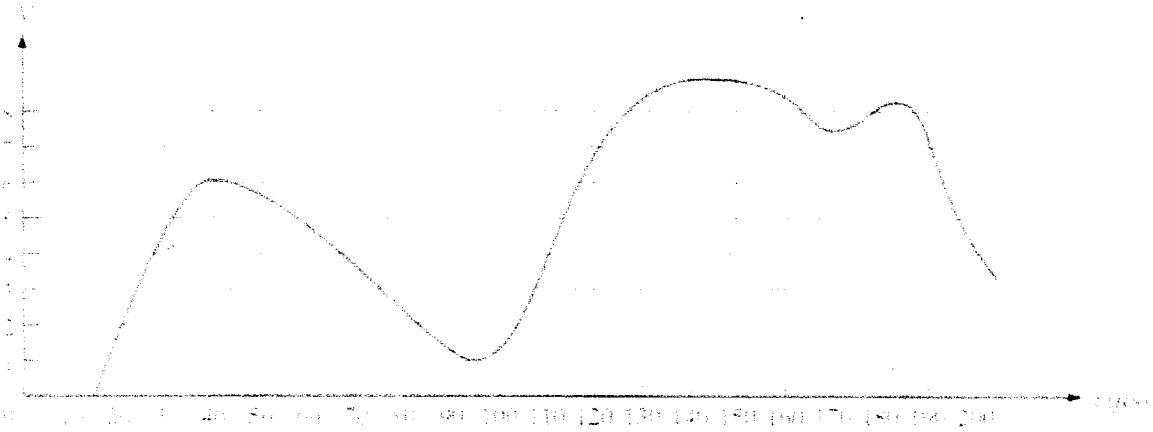


Figure 1

QUESTION 2

(i) Draw an ADC and explain the operation of each part. [6 Marks]

(ii) Determine the binary output code of a 3-bit flash ADC for the analog input signal in figure 2. The sampling rate is 100khz. [6 Marks]



QUESTION 3

(i) List the functions of the bus controller [4 Marks]

(ii) Explain the functions of a clock generator in a CPU [4 Marks]

(ii) Explain the bus multiplexing mechanism in an 8088 microprocessor [4 Marks]

QUESTION 4

(i) Use 16k x 4 DRAMs to build a 64k x 8 RAM. Show the logic diagrams [6 Marks]

(ii) using a block diagram, show how 64k x 1 dynamic RAMs can be expanded to build a 256k x 4 RAM [6 Marks]

QUESTION 5

Design a ROM for conversion of a single-digit BCD to:

(i) Access-3 code [6 Marks]

(ii) Access a cube root (x^3) [6 Marks]

QUESTION 6

(i) Define a microprocessor and name the basic elements [5 Marks]

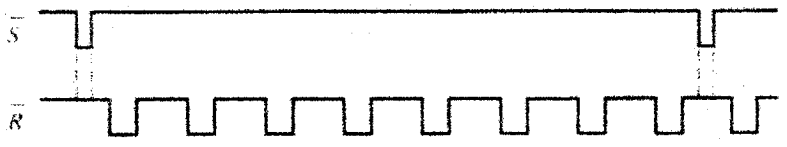
(ii) How are data transferred from one unit to another in a microcomputer? [4 Marks]

(iii) What is the purpose of a cache memory? [3 Marks]

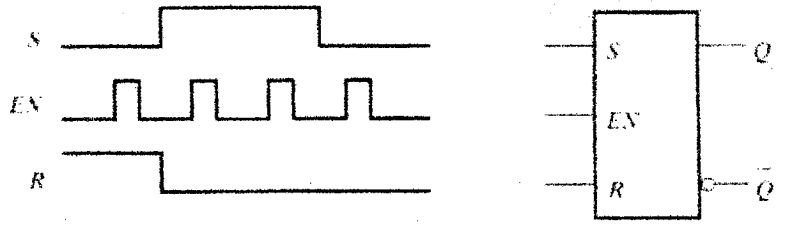
QUESTION 7

(i) If the waveform in (a) is applied to an active-low S-R latch, sketch the resulting Q output waveform in relation to the inputs. Assume that Q starts low. [6 Marks]

(ii) For a gated S-R latch, determine the Q and Q' outputs for the inputs in (b). Show them in proper relation to the Enable. Assume that Q starts low. [6 Marks]



(a)



(b)

END OF EXAM

University of Zambia

School of Natural Sciences

Department of Computer Studies

CST2012 Final Exam

Programming in Java II

This exam has four sections. Section A, B and C has compulsory questions and each Section carries 30, 10 and 30 points respectively. Section D has five questions and you are expected to answer any three of the five Questions. Each question in Section D carries 10 points.

Section A: Multiple Choice Questions (30 points)

1) What will happen when you attempt to compile and run the following code?

```
class Background implements Runnable{
  int i=0;
  public int run(){
        while(true){
              i++;
              System.out.println("i="+i);
        } //End while
    return 1;
  }//End run

}//End class
```

a) It will compile and the run method will print out the increasing value of i.
b) It will compile and calling start will print out the increasing value of i.
c) The code will cause an error at compile time.
d) Compilation will cause an error because while cannot take a parameter of true.

2) A Frame has its Layout Manager set to the default of FlowLayout. What code would be correct to change to another Layout Manager.
a) setLayoutManager(new GridLayout());
b) setLayout(new GridLayout(2,2));
c) setGridLayout(2,2);
d) setBorderLayout();

3) Which of the following methods can be legally inserted in place of the comment //Method Here?

```
class Base{
 public void amethod(int i) { }
}

public class Scope extends Base{
 public static void main(String argv[]){
 }
 //Method Here
}
```

a) void amethod(int i) throws Exception {}
b) void amethod(long i)throws Exception {}
c) void amethod(long i){}
d) public void amethod(int i) throws Exception {}

4) What will happen when you attempt to compile and run the following code?

```
public class Tux extends Thread{
    static String sName = "vandeleur";
    public static void main(String argv[]){
    Tux t = new Tux();
```

```
        t.piggy(sName);
        System.out.println(sName);

        }
        public void piggy(String sName){
            sName = sName + " wiggy";
        start();
        }
        public void run(){

        for(int i=0;i < 4; i++){
            sName = sName + " " + i;

        }
        }

    }
```

a) Compile time error
b) Compilation and output of "vandeleur wiggy"
c) Compilation and output of "vandeleur wiggy 0 1 2 3"
d) Compilation and output of either "vandeleur", "vandeleur 0", "vandeleur 0 1" "vandaleur 0 1 2" or "vandaleur 0 1 2 3"

5) What will happen if you attempt to compile and run the following code?

```
class Base {}
class Sub extends Base {}
class Sub2 extends Base {}
public class CEx{
   public static void main(String argv[]){
   Base b=new Base();
   Sub s=(Sub) b;
   }
}
```

a) Compile and run without error
b) Compile time Exception
c) Runtime Exception

6) What will be the result of attempting to compile and run the following code?

```
abstract class MineBase {
 abstract void amethod();
 static int i;
}
public class Mine extends MineBase {
 public static void main(String argv[]){
 int[] ar=new int[5];
```

```
for(i=0;i < ar.length;i++)
System.out.println(ar[i]);
}
}
```

a) a sequence of 5 0's will be printed
b) Error: ar is used before it is initialized
c) Error Mine must be declared abstract
d) IndexOutOfBoundes Error

7) Which of the following are legal identifiers
   a) 2variable
   b) variable2
   c) _whatavariable
   d) _3_
   e) $anothervar
   f) #myvar

8) Which of the following best describes the use of the synchronized keyword?
   a) Allows two process to run in paralell but to communicate with each other
   b) Ensures only one thread at a time may access a method or object
   c) Ensures that two or more processes will start and end at the same time
   d) Ensures that two or more Threads will start and end at the same time

9) Which of the following are correct event handling methods
   a) mousePressed(MouseEvent e){}
   b) MousePressed(MouseClick e){}
   c) functionKey(KeyPress k){}
   d) componentAdded(ContainerEvent e){}

10) Which of the following are methods of the Thread class?
   a) yield()
   b) sleep(long msec)
   c) go()
   d) stop()

11) Given the following class definition which of the following can be legally placed after the comment line //Here ?

```
class Base{
public Base(int i){}
}

public class MyOver extends Base{
public static void main(String arg[]){
        MyOver m = new MyOver(10);
        }
    MyOver(int i){
        super(i);
    }
```

```
    MyOver(String s, int i){
        this(i);
        //Here
    }
}
```

a) MyOver m = new MyOver();
b) super();
c) this("Hello",10);
d) Base b = new Base(10);

12) Given the folowing classes which of the following will compile without error?

```
interface IFace{}
class CFace implements IFace{}
class Base{}
public class ObRef extends Base{
  public static void main(String argv[]){
    ObRef ob = new ObRef();
    Base b = new Base();
    Object o1 = new Object();
    IFace o2 = new CFace();
  }
}
```

a) o1=o2;
b) b=ob;
c) ob=b;
d) o1=b;

13)

```
class Base{}
public class MyCast extends Base{
  static boolean b1=false;
  static int i = -1;
  static double d = 10.1;
  public static void main(String argv[]){
    MyCast m = new MyCast();
    Base b = new Base();
    //Here
  }
}
```

Which of the following, if inserted at the comment //Here will allow the code to compile and run without error

a) b=m;
b) m=b;
c) d =i;
d) b1 =i;

14) What will happen when you attempt to compile and run this code

```
//Demonstration of event handling
import java.awt.*;
import java.awt.event.*;
public class MyWc extends Frame implements WindowListener{
public static void main(String argv[]){
      MyWc mwc = new MyWc();
      }
      public void windowClosing(WindowEvent we){
            System.exit(0);
            }//End of windowClosing
     public void  MyWc(){
      setSize(300,300);
      setVisible(true);
      }
}//End of class
```

a) Error at compile time
b) Visible Frame created that that can be closed
c) Compilation but no output at run time
d) Error at compile time because of comment before *import* statements

15) What will happen when you attempt to compile and run the following code

```
import java.io.*;
class Base{
  public void amethod()throws FileNotFoundException{}
}

public class ExcepDemo extends Base{
  public static void main(String argv[]){
  ExcepDemo e = new ExcepDemo();
  }

  public void amethod(){}
  protected ExcepDemo(){
  try{
    DataInputStream din = new DataInputStream(System.in);
    System.out.println("Pausing");
    din.readByte();
    System.out.println("Continuing");
    this.amethod();
  }catch(IOException ioe) {}

  }
}
```

a) Compile time error caused by protected constructor
b) Compile time error caused by *amethod* not declaring Exception
c) Runtime error caused by amethod not declaring Exception
d) Compile and run with output of "Pausing" and "Continuing" after a key is hit

16) Under what circumstances might you use the yield method of the Thread class
   a) To call from the currently running thread to allow another thread of the same or higher priority to run
   b) To call on a waiting thread to allow it to run
   c) To allow a thread of higher priority to run
   d) To call from the currently running thread with a parameter designating which thread should be allowed to run

17) What will happen when you attempt to compile and run the following code?

```
public class Bground extends Thread{
public static void main(String argv[]){
        Bground b = new Bground();
        b.run();
    }
    public void start(){
        for (int i = 0; i <10; i++){
            System.out.println("Value of i = " + i);
        }
    }
}
```

   a) A compile time error indicating that no run method is defined for the Thread class
   b) A run time error indicating that no run method is defined for the Thread class
   c) Clean compile and at run time the values 0 to 9 are printed out
   d) Clean compile but no output at runtime

18) What most closely matches the appearance when this code runs?

```
import java.awt.*;
public class CompLay extends Frame{
public static void main(String argv[]){
  CompLay cl = new CompLay();
  }

CompLay(){
  Panel p = new Panel();
  p.setBackground(Color.pink);
  p.add(new Button("One"));
  p.add(new Button("Two"));
  p.add(new Button("Three"));
  add("South",p);
  setLayout(new FlowLayout());
  setSize(300,300);
  setVisible(true);
  }
}
```

   a) The buttons will run from left to right along the bottom of the Frame
   b) The buttons will run from left to right along the top of the frame
   c) The buttons will not be displayed
   d) Only button three will show occupying all of the frame

19) How do you change the current layout manager for a container
   a) Use the setLayout method
   b) Once created you cannot change the current layout manager of a component
   c) Use the setLayoutManager method
   d) Use the updateLayout method

20) How do you indicate where a component will be positioned using Flowlayout?
   a) North, South,East,West
   b) Assign a row/column grid reference
   c) Pass a X/Y percentage parameter to the add method
   d) Do nothing, the FlowLayout will position the component

21) What best describes the appearance of an application with the following code?

```
import java.awt.*;
public class FlowAp extends Frame{
public static void main(String argv[]){
  FlowAp fa=new FlowAp();
  fa.setSize(400,300);
  fa.setVisible(true);

}

FlowAp(){
     add(new Button("One"));
     add(new Button("Two"));
     add(new Button("Three"));
     add(new Button("Four"));
  }//End of constructor
}//End of Application
```

   a) A Frame with buttons marked One to Four placed on each edge.
   b) A Frame with buutons marked One to four running from the top to bottom
   c) A Frame with one large button marked Four in the Centre
   d) An Error at run time indicating you have not set a LayoutManager

22) What will happen when you attempt to compile and run this code?

```
public class MyMain{
public static void main(String argv){
     System.out.println("Hello cruel world");
     }
}
```

   a) The compiler will complain that main is a reserved word and cannot be used for a class
   b) The code will compile and when run will print out "Hello cruel world"
   c) The code will compile but will complain at run time that no constructor is defined
   d) The code will compile but will complain at run time that main is not correctly defined

23) What will happen when you attempt to compile and run this code?

```
abstract class Base{
     abstract public void myfunc();
```

```
    public void another(){
    System.out.println("Another method");
    }
}

public class Abs extends Base{
    public static void main(String argv[]){
    Abs a = new Abs();
    a.amethod();
    }
    public void myfunc(){
        System.out.println("My Func");
        }
    public void amethod(){
    myfunc();
    }
}
```

a) The code will compile and run, printing out the words "My Func"
b) The compiler will complain that the Base class has non abstract methods
c) The code will compile but complain at run time that the Base class has non abstract methods
d) The compiler will complain that the method myfunc in the base class has no body, nobody at all to love it

24) Consider

```
public class MyClass{
        public MyClass(){/*code*/}
        // more code...
}
```

To instantiate MyClass, you would write?

a) MyClass mc = new MyClass();
b) MyClass mc = MyClass();
c) MyClass mc = MyClass;
d) MyClass mc = new MyClass;
e) It can't be done. The constructor of MyClass should be defined as public void MyClass(){/*code*/}

25) You read the following statement in a Java program that compiles and executes.
submarine.dive(depth);
What can you say for sure?

a) depth must be an int
b) dive must be a method.
c) dive must be the name of an instance field.
d) submarine must be the name of a class
e) submarine must be a method.

26) A constructor

a) must have the same name as the class it is declared within.

b) is used to create objects.
c) may be declared private
d) a and b
e) a,b and c

27) Which of the following puts "Hello" starting at X=20 Y=50? Assume that graph holds a Graphics object reference.
a) drawString("Hello", 20, 50);
b) graph.drawString(20, 50, "Hello");
c) graph.println("Hello");
d) graph.drawString("Hello", 20, 50);

28) Which code declares class A to belong to the mypackage.financial package?
a) package mypackage;
package financial;
b) import mypackage.*;
c) package mypackage.financial.A;
d) import mypackage.financial.*;
e) package mypackage.financial;

29) What happens when you compile the following code

```
public class AQuestion{
        private int i = giveMeJ();
        private int j = 10;
        private int giveMeJ(){
                return j;
        }
        public static void main(String args[]){
                System.out.println((new AQuestion()).i);
        }

  }
```

a) Compiler error complaining about access restriction of private
b) variables of AQuestion.
c) Compiler error complaining about forward referencing.
d) No Compilation error - The output is 0;
e) No Compilation error - The output is 10;

30) Read the following code below.

```
public interface AQuestion{
  public abstract void someMethod() throws Exception;
}
```

A Class implementing this interface should
a) Necessarily be an abstract class.
b) Should have the method public abstract void someMethod();
c) Should have the method public void someMethod() which has to throw an exception which is a subclass of java.lang.Exception.

d) Should have the method public void someMethod() which need not throw an Exception.

Section B: True or False Questions (10 points)

1. An Interface can never be private or protected.
2. Java supports multi-threaded programming.
3. Threads in a single program can have different priorities.
4. Multiple threads can manipulate files and get user input at the same time.
5. Two threads can never act on the same object at the same time.
6. Threads are created and started with different methods.
7. You can call an abstract method from a non abstract method?
8. A class has always a constructor (possibly automatically supplied by the java compiler).
9. All methods in an abstract superclass must be declared abstract.
10. A class declared final cannot be subclassed. Every method of a final class is implicitly final.
11. Overloaded methods can have different return values, and must have different parameter lists. Two methods differing only by return type will result in a compilation error.
12. If multiple listeners are added to a component only events for the last listener added will be processed
13. Adding multiple listeners to a comnponent will cause a compile time error
14. Adding more classes via import statements will cause a performance overhead, only import classes you actually use.
15. Under no circumstances can a class be defined with the *private* modifier
16. An interface cannot be instantiated
17. You can have an if statement without an else.
18. The same case in a switch can have two breaks.
19. Java supports multiple inheritance
20. UDP sockets do not use on acknowledgements.

Section C: Short answer questions (30 points)

1. Name two containers which use Border Layout as their default layout?
2. What do you understand by Synchronization?
3. What are the similarities/differences between an Abstract class and Interface?
4. There are two classes: A and B. The class B need to inform a class A when some important event has happened. What Java technique would you use to implement it?
5. Define an Abstract class?
6. Define an Interface?
7. Explain the Encapsulation principle.
8. What's the difference between the methods sleep() and wait()
9. Explain the Inheritance principle.
10. Explain the Polymorphism principle.
11. Why would you use a synchronized block vs. synchronized method?
12. What are methods and how are they defined?
13. What Access Specifiers are available in Java? Explain their usage.
14. What is the difference between a UDP and TCP socket? When do you use each socket?
15. Illustrate the life-cycle of a socket on the Server side using an appropriate diagram.
16. Illustrate the life-cycle of a thread using an appropriate diagram.

17. What is the relationship between the Canvas class and the Graphics class?
18. How are the elements of a BorderLayout organized?
19. Name four Container classes.
20. How are this() and super() used with constructors?

Section C: Answer any two Questions (30 points)

1) Write a Graphical user interface that has five buttons. One in the center and the other four surrounding the one. The graphical user interface should be closeable.
2) Write a TCP echo Server. Write a client class to test the echo Server.
3) Illustrate the concept of the solution to the producer/consumer problem using two threaded classes.
4) In mathematics, a Mersenne number, named after Marin Mersenne, is a positive integer that is one less than a power of two:
   $M_p = 2^p - 1$
   Write an application that calculates the first 3 perfect and mersenne numbers.
5) Write a java application that draws a circle that shrinks with time. The user should be allowed to click on a button to start and stop the shrinking of the circle.

THE UNIVERSITY OF ZAMBIA
Department of Computer Studies

University Examinations

CST3022 – Programming Language Paradigms

Thursday, 22 April 2010, 14:00 Hours

INSTUCTIONS: There are **SIX (6)** questions in this examination. You are required to answer **FIVE(5)** of them. All questions have equal weight. Please be as concise and precise as possible. Good luck!

DURATION : 3 Hours

1.

a. Outline three features of low-level programming languages. 3 marks

b. List three drawbacks of low-level languages. 3 marks

c. Explain the difference between low-level languages and high level languages by giving two advantages and two disadvantages of each. 8 Marks

d. Give three factors that led to so many high-level programming languages. 3 Marks

e. Give three reasons that make some languages more successful than others. 3 marks

2.

a. Draw a labelled diagram illustrating the compilation process, indicating the following

- the front end
- the back end
- the form of the program from one phase to the other 10 Marks

b. Briefly explain the difference between compilation and interpretation. 6 marks.

c. give two advantages of compilation and interpretation. 4 marks

3.

a. Give four attributes of a variable in programming languages. 4 Marks

b. Explain the three storage allocation procedures in programming languages. 6 Marks

c. Differentiate between static and dynamic binding. 2 Marks

d. Given the following code

```
x,y: Integer;
procedure A;
    x:Integer
    x:=4;
    B;
end
procedure B
    x:=8;
end
main
    x:=10;
    A;
    print(x)
end.
```

What is the output if the binding is

i. Static. 4 Marks

ii. Dynamic. 4 Marks

show your derivation using the stack of activation frames.

4.

a. Draw a tree illustrating the hierarchy of programming language paradigms with "Programming Languages" at the root and four paradigms. 8 Marks

b. Describe each paradigm in the tree above and, where possible, state the model of computation and give an example of a programming language. 12 Marks

5.

a. explain the following giving three examples. 6 Marks

   i. static semantics

   ii. dynamic semantics

b. Differentiate between synthesised and inherited grammars. 4 Marks

c. Given the following syntax of addition and multiplication add an S-attribute grammar for the syntax. 10 Marks

```
E ::= E + T
E ::= T
T ::= T * F
T ::= F
F ::= const
```

6.

a. Briefly describe the operations of each of the following parameter passing modes. Address the memory issues and favourability of the methods. 8 Marks

   i. Pass by value

   ii. Pass by result

   iii. Pass by value result

   iv. Pass by reference

b. consider the following piece of code

```
x, y, z: real;
procedure swap_sum( a: real, b: real s: real)
        t: real;
        t := a;
        a := b;
        b := t;
        s := a + b;
end
main
        x := 4;
        y := 5;
        z := 0;
        swap_sum(x, y, z);
        write(x, y, z);
        end
```

What is the output if the language uses – 12 Marks

   i. pass by value

   ii. pass by value result if s is an out-mode variable and a and b are in mode variables

   iii. pass by reference [Show how you derive the answers]

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

DMZ

THE UNIVERSITY OF ZAMBIA

Department of Computer Studies

EXAMINATION

CST3032 – ARTIFICIAL INTELLIGENCE

Wednesday, April 28, 2010, 09:00AM

INSTRUCTIONS : Answer five (5) out of the six (6) given questions. Good luck!

DURATION : 3 hours

1.

a. Define the following
   i. An agent
   ii. A rational agent

b. Differentiate between the following types of agent environments
   i. Deterministic and Stochastic
   ii. Static and dynamic

c. For each of the following agents, develop a PEAS description
   i. Intelligent medical diagnosis system.
   ii. Interactive English tutor

2.

a. Explain the operations of the following blind search mechanisms
   i. Breadth-first search (BFS)
   ii. Depth-first search (DFS)

b. Show that if the branching factor and the depth of the search tree are b and d respectively then the memory requirements for
   i. BFS is of O(bd) and
   ii. DFS is of O(bd)

c. DFS is known to be not complete as it may find itself in a loop. Describe what completeness of a search mechanism means.

3.

a. Consider the following. You have two jugs, measuring 8l and 3l and a water tap. You need to measure 2l. Formulate this as a search problem by defining
   i. State representation
   ii. Initial state
   iii. Goal test
   iv. Operators (Not more than 6 operators for this problem)

b. Draw the DFS search tree to the depth where a goal is found with the following
   - No return to ancestor
   - Children are generated according to the order of operators
   - Backtracking if no new children are a generated

4.

a. Define the following
   i. Admissible heuristic
   ii. Dominant heuristic

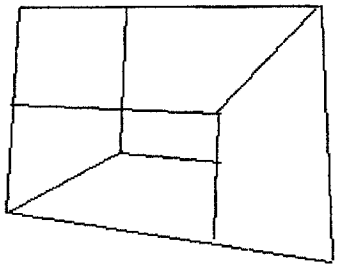
b. Show that if h_1 and h_2 are admissible then
   i. $h_{avg} = (h_1 + h_2)/2$ is also admissible
   ii. $h_{max} = \max(h1, h2)$ is also admissible
   iii. which of the two is dominant over the other h_{avg} and h_{max}

c. Show that if the heuristic is admissible the A* is optimal

5.

a.
   i. What is a constraint satisfaction problem (CSP)?
   ii. Give three examples of real life problems you consider to be CSPs

b. Consider the floor plan in the figure below.



You have been asked to colour this plan. Naturally for it to have segments distinguished, no two adjacent segments should have the same colour.

i. Redraw the plan with the segments labelled with letters A to F
ii. Formulate this problem as a CSP
iii. Draw the constraint graph
iv. From the graph, suggest the minimum number of colours required for you to accomplish this task and list the colours of your choice.
v. Assign these colours using the arc-consistency heuristic. In case of a tie use the alphabetical order.

6.

a. Define the following
   i. A model of a sentence
   ii. Satisfiability of a sentence.

b. Given the sentence $(A \wedge \neg B) \vee C$, how many models does it have? Show using the enumeration table.

c. Let p, q, and r be the following propositions:
   - p: You get an A on the final exam
   - q: You do every exercise in the book.
   - r: You get an A in this class.

   Write the following formulas using p, q, and r and logical connectives.
   i. You get an A in this class, but you do not do every exercise in the book.
   ii. To get an A in this class, it is necessary for you to get an A on the final.
   iii. Getting an A on the final and doing every exercise in the book is sufficient for getting an A in this class.

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

DMZ

The University of Zambia

School of Natural Sciences

Computer Studies Department

EXAM:		**APRIL 2010 EXAM - SEMESTER TWO FINAL**
COURSE:		**CST3142 – SOFTWARE ENGINEERING II**
DURATION:		**3 HOURS**
VENUE	**:**	**API**

INSTRUCTIONS

- ***This paper is divided into two sections***
- ***ANSWER A TOTAL OF FIVE QUESTIONS!***
  - *SECTION A has **ONE COMPULSORY question***
  - *SECTION B has **FIVE questions**, answer any **FOUR***
- *All questions carry equal marks (**20 marks**)*
- *Clearly number your answers*
- *Use the marks as a guide to the detail required in your answers while keeping your answers concise and relevant.*

GOOD LUCK!!

SECTION A (Answer all questions in this section)

A correct answer carries 1 mark. A wrong answer will attract a deduction of 0.25 marks. No answer carries 0 marks.

1. You are the Project Manager assigned to build a next generation vehicle. You identify a dependency that the wheels must be designed and developed before the assembly of the vehicle can be performed. This is an example of which type of dependency?

    A. External
    B. Discretionary
    C. Soft Logic
    D. Mandatory

2. You are the Project Manager assigned to build a next generation vehicle. You identify a dependency that before the vehicle can be sold; it must be approved by the Government regulatory authority. This is an example of which type of dependency?

    A. External
    B. Discretionary
    C. Soft Logic
    D. Mandatory

3. Of the following, which does the scope statement not provide?

    A. Project justification
    B. Project product
    C. Project manager authority
    D. Project objective

4. The level of accuracy for order of magnitude estimation is

    A. -25% to +75%
    B. -25% to +50%
    C. -25% to +25%
    D. -25% to +10%

5. You are required to estimate the time to paint a large wall. You know it takes two hours to paint one square foot of wall. The wall has an area of 30 square foot. So you estimate that it will take 60 hours to paint the wall. Which estimation model are you using?
    A. Bottom-up
    B. Parametric modeling
    C. Analogous
    D. Expert judgment

6. What is the difference between a project baseline and a project plan?
   A. Project plans change as needed, while baselines change only at milestones
   B. Project plans and baselines do not change—they are amended
   C. Project plans change as needed, while baselines are snapshots of the project plan
   D. Baselines are control tools, while project plans are execution tools

7. You are the project manager for your company, Huntsville Construction. The company has an important customer who has requested a special floor plan be created for one of his properties. Your company agrees, creates a standard contract with the customer, and your manager assigns you to manage this project. The project was launched because of which one of the following?
   A. A customer request
   B. A change in the technology your customer is creating
   C. A legal requirement (contractual)
   D. An organizational need

8. Which of the following is not an attribute of a project?
   A. Definite starting date
   B. Has no definite end date
   C. Creates a product, service, or results
   D. Requires resources

9. Of the following, which is not part of project scope management?
   A. Scope planning
   B. Scope verification
   C. Quality assurance
   D. Create WBS

10. You are the project manager for the HGD Project and will need as many inputs to the scope planning as possible. Of the following, which one is not an organizational process asset?
   A. Organizational procedures
   B. Organizational policies
   C. WBS
   D. Historical information

11. You are the project manager for the NBG Project. This project must be completed within six months. This is an example of which of the following?
   A. Schedule
   B. Assumption
   C. Constraint
   D. Planning process

12. Which of the following best describes the project scope statement?
   A. The description of the project deliverables
   B. The authorizing document that allows the project manager to move forward with the project and to assign resources to the tasks
   C. The process of managing all of the required work—and only the required work—to create the project's deliverables
   D. The process of planning and executing all of the required work in order to deliver the project to the customer

13. You are the project manager for the JHN Project. Mike, a project manager you are mentoring, does not know which plan he should reference for guarding the project scope. Which of the following plans does Mike need?
    A. The scope management plan
    B. The scope change control system
    C. The scope verification
    D. The scope charter
14. Which of the following is an output of scope verification?
    A. WBS template
    B. Rework
    C. Formal acceptance
    D. SOW acceptance
15. Where can the project manager find work package information such as the code of an account identifier, a statement of work, information on the responsible organization, quality requirements and information on the required resources?
    A. Project plan
    B. WBS
    C. WBS dictionary
    D. Project management plan

16. Which of the following is an output of scope change control?
    A. Workarounds
    B. Recommended corrective action
    C. Transference
    D. Risk assessment

17. You are the project manager for a pharmaceuticals company. A new government regulation will change your project scope. For the project to move forward and be in accordance with the new regulation, your next action should be?
    A. Prepare a new baseline to reflect the government changes
    B. Notify management
    C. Present the change to the CCB
    D. Create a feasibility study

18. You have finished the project scope according to plan. For the customer to accept the project, what must happen next?
    A. Nothing. The plan is complete so the project is complete.
    B. Scope verification should be conducted.
    C. Lessons learned should be finalized.
    D. Proof-of-concept should be implemented.

19. One of the stakeholders of the project you are managing asks why you consider the scope statement so important in your project management methodology. You answer her question with which of the following?
    A. It is mandatory to consult the plan before authorizing any change.
    B. Project managers must document any changes before approving or declining them.
    C. The project scope statement serves as a reference for all change requests to determine if the change is in or out of scope.
    D. The project plan and EVM work together to assess the risk involved with proposed changes.

20. Which one of the following provides the least accuracy in estimating?
    A. Rough order of magnitude
    B. Budget estimate
    C. Definitive estimate
    D. WBS estimate

SECTION B (Answer any four (4) questions in this section)

QUESTION TWO

a) Define the three processes of Project Quality Management. **[6 marks]**

b) With regards to a project charter; **[8 marks]**

   i. Describe the fundamental Information Included in a project Charter Document

   ii. When and whom should prepare a project charter?

   iii. Why should a project manager NOT begin a project without an approved project charter?

   iv. How can the project charter be used during completion of project work?

c) Using a graph as an aid, explain how the following issues; Project cost, Staffing Level, Influence of stakeholders and Cost of changes behave over the life cycle of a typical project. **[6 marks]**

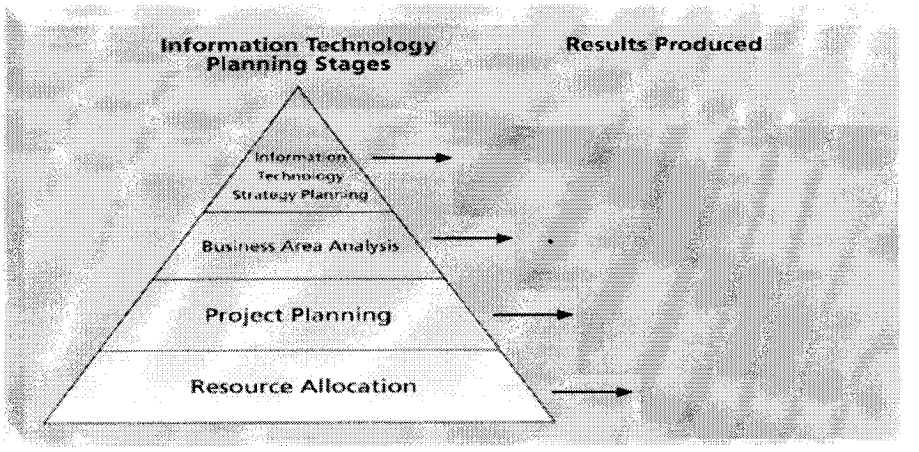
QUESTION THREE

a) It is crucial to align IT projects with business strategy.

   i. How does an organization make use of a **SWOT** analysis?

   ii. What results are produced from each of the stages in the pyramid below?

[6 marks]



b) A company is considering two internal projects, of which it will undertake only one, and you must recommend which one of the projects should be undertaken.

Project A would run for four years and cost $8,000 in year 1, $5, 000 in year 2 and $2,000 each year in years 3 and4, and Project B would run for three years and cost $6,000 in year 1, $5, 000 in year 2 and $2,000 in year 3. The company's discount rate is 10%.

Project A would provide a cash flow of -$6,000, $4,000, $6,000 and $5,000 at the end of each year for 4 years respectively, and Project B would provide a cash flow of -$4,000, $3,000 and $4,000 at the end of each year for 3 years respectively

i. Perform a financial analysis for the two projects. Calculate the NPV, ROI, and year in which payback occurs. **[12 marks]**

ii. Which project would you recommend? **[2 marks]**

QUESTION FOUR

A non-profit organization would like you to lead a Web site development project for them. The organization has Internet access that includes space on a Web server, but has no experience developing Web pages or Web sites. In addition to creating their Web site, they would like you to train two people on their staff to do simple Web page updates. The organization wants their Web site to include the following basic information, as a minimum: description of the organization (history, mission, and recent events), list of services and contact information. They want the Web site to include graphics (photographs and other images) and have an attractive easy to use layout.

i. What is the definition of Project Scope? **[2 marks]**

ii. What is the objective of Project Scope Management? **[2 marks]**

iii. Create a level three WBS for this project organized around the Project Management process groups **[10 marks]**

iv. What elements constitute the Scope baseline and of what use is it? **[4 marks]**

v. State one strategy a project manager might use to prevent scope creep. **[2 marks]**

QUESTION FIVE

(a) With regards to project Time Management

i. List one output for each of the processes involved. **[3 marks]**

ii. Outline three reasons for creating a dependency between activities. **[3 marks]**

(b) Consider the table below with Network Diagram data for a small project.

ACTIVITY	INITIAL NODE	FINAL NODE	ESTIMATED DURATION
A	1	2	2
B	2	3	2
C	2	4	3
D	2	5	4
E	3	6	2
F	4	6	3
G	5	7	6
H	6	8	2
I	6	7	5
J	7	8	1
K	8	9	2

i. Using a network diagram calculate the early and late start and finish dates of each activity for the Project. **[5 marks]**

ii. What are the free and total slack for all activities **[5 marks]**

iii. How many possible paths are there from the start to the end of the project? **[3 mark]**

iv. Identify the tasks on the critical path, and the length of the critical path **[1 mark]**

QUESTION SIX

(a) The first process in Cost Management involves *cost estimating*.

i. Define cost estimating. **[1 marks]**

ii. Discuss the three types of cost estimates with regards to why they are done and how accurate they are. **[9 marks]**

(b) Figure below provides sample earned value information for a four month project.

2010	03-May				31-May				28-Jun				02-Aug				
Tasks:	1	2	3	4	1	2	3	4	1	2	3	4	5	1	2	3	4
Requirements	40	40	30	20													
Design			10	20	30	30											
Code & Unit Test					10	10	30	25									
Integrate & Test							10	15	40	40	40	40	20				
Write User's Manual													20	30			
Write Final Report														10	40	40	
Demonstrate																	40

The values shown indicate time estimates. Billing will be at a rate of $20 per hour.

At the end of July the project looks like this;

Tasks	**Planned Complete**	**Actual Complete**	**Cost status**
Requirements	100%	100%	$ 1,400
Design	100%	100%	$ 2, 500
Code & Unit Test	100%	100%	$ 1,000
Integrate & Test	100%	60%	$ 3,100
Write User's Manual	70%	50%	$500

i. Using this information fill in the table below. **[10 marks]**

Earned Value Analysis	**Computation**	**Answer**
PV		
EV		
AC		
CPI		
SPI		
CV		
SV		
BAC		
EAC		
ETC		

THE END

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF COMPUTER STUDIES

2010 SEMESTER TWO EXAMINATION

TITLE OF PAPER : **ADVANCED OPERATING SYSTEMS AND DISTRIBUTED SYSTEMS**

COURSE CODE : **CST4012**

LEVEL : **FOURTH (4th) YEAR**

DATE : 3rd May, 2010

DURATION : THREE (3) HOURS

INSTRUCTIONS

The examination paper is subdivided into three sections. Each section has its own instructions. Read through the instructions carefully before attempting any question.

SECTION A

This section constitutes 15 marks of the whole paper. Each question is worth 1 mark. Some questions have more than one correct option. Any partially correct answers will be considered wrong.

1. Which of the following options causes less packet loss in a wireless network?
    a) External interference.
    b) Buffer over flow.
    c) Processing delay.
    d) Bandwidth variations.

2. What kind of a network is a Digital Subscriber Line (DSL)?
    a) WAN.
    b) LAN.
    c) PAN.
    d) MAN.

3. In which type of network is routing absent?
    a) WAN.
    b) LAN.
    c) PAN.
    d) MAN.

4. A service interface is used in Clients-Server systems where as a remote interface is used in distributed systems. Which statements are true about the properties of these interfaces?
    a) A service interface can pass reference to a remote objects where as a remote interface cannot.
    b) A remote interface can pass reference to remote objects where as a service interface cannot.
    c) Both a service and a remote interface can pass objects as input and output.
    d) A service interface can pass objects as input and output.

5. Which of the following statement relates to objects in a distributed system?
    a) Objects receive notifications of events of other objects in which they have registered.
    b) Objects are passed both by reference and by value.
    c) Objects communicate with other objects in other processes.
    d) None of the above.

6. Which of the options can be attributed to the inability by high-level scripting languages to access memory in an impermissible way?
    a) Code is from trusted sources.
    b) Absence of machine addresses.
    c) The absence of machine addresses in trusted code.
    d) The use of JMP command.

7. Which of the following is not an example of mobile code?
    a) Agent.
    b) Applet.
    c) Worm.
    d) Postscript.
8. Data confidentiality is one of the goals computer systems, from a security perspective. Which of the following threats corresponds to it?
    a) Tempering with data.
    b) Exposure of data.
    c) Denial of service.
    d) Both exposure of data and denial of service.

9. Below are equations relating to the performance of a distributed system? Which one is correct?
    a) Latency = Data transfer Rate + Message transmission rate / Length.
    b) Data transfer rate= Latency/Length + Message transmission rate.
    c) Message Transmission Rate = Latency +length/data transfer rate.
    d) Length = Data Transfer Rate + Message Transmission Rate/Latency.
10. Which of the following errors is more prominent in distributed systems?
    a) Software errors
    b) Network errors
    c) Human(user) errors
    d) Both human(user) and network errors
11. Which of the following uses the interface definition language?
    a) Web Services.
    b) RMI.
    c) CORBA.
    d) CORBA and RMI.
12. Which of the following multiprocessor operating system requires a mutex?
    a) The kind in which each CPU has its own operating system.
    b) Master slave multiprocessor.
    c) Symmetric multiprocessors.
    d) Both master slave multiprocessor an symmetric multiprocessors.

13. Which of the following are cross platformed standards?
    a) Web services
    b) RMI
    c) CORBA
    d) None of the above
14. Which of the following options are examples of a distributed system?
    a) The internet
    b) The World Wide Web
    c) Automatic Banking
    d) None of the above
15. What advantage does private key cryptography has over public key cryptography?
    a) The sender and receiver both have the shared secret key.
    b) Manageable decryption and encryption time.
    c) Impossible to discover the decryption key if the encryption key is well chosen.
    d) The key is easy to remember.

SECTION B

This section constitutes 25 marks of the whole paper. Read each question carefully before answering.

1. What advantage does interpreted code have over executable code — 1mark
2. Define the following terms:
   i. What is a virus?
   ii. What is a one way function? — 2 mark
3. List three general principles on which various authentication methods are based. — 3 marks
4. What is login spoofing? How can you thwart this kind of attack — 2 marks
5. Mobility has proved to be a serious problem to curb in distributed systems. Explain why this is so. — 2 marks
6. Describe the failure model for TCP. — 3 marks
7. Describe an UMA multiprocessor that uses multistage switching networks — 5 marks
8. List three key characteristics of NUMA multiprocessors — 3 marks
9. Choose a topic to write about on multiprocessor scheduling — 5 marks
   i. Time sharing,
   ii. Space Sharing,
   iii. Gang Scheduling.

SECTION C

This section constitutes 20 marks of the whole paper. Answer all questions.

1. You have been hired as a consultant for a project to develop an application that will be developed in various languages .The application will integrate business amongst various organizations. Your clients are not sure whether to use CORBA or web services.

   What would advise them and why? — 2 marks

   In what case would advise them to choose the other option? Explain why. — 2 marks

2. Compare TCP and UDP stating their strengths and weaknesses. Give examples of applications for which each of them would be an ideal choice.

   4 marks

3. Write simple 3-tiered architecture java program that uses CORBA to implement debit and credit operations over an account. A client may want to check his balance before carrying out other transaction. — 12 marks

The University of Zambia

School of Natural Sciences

Computer Studies Department

EXAM:	**APRIL 2010 EXAM - SEMESTER TWO FINAL**
COURSE:	**CST4122 – FUNDAMENTALS OF COMPILERS**
DURATION:	**3 HOURS**
VENUE:	**LIBRARY BASEMENT**

INSTRUCTIONS

- ***This paper contains SIX (6) questions***
  - ***ANSWER A TOTAL OF FIVE QUESTIONS***
  - ***QUESTION ONE PLUS ANY FOUR OTHERS***
- *All questions carry equal marks (**20 marks**)*
- *Clearly number your answers*
- *Use the marks as a guide to the detail required in your answers while keeping your answers concise and relevant.*

GOOD LUCK!!

SECTION A - *compulsory question*

QUESTION ONE

a) Consider the following grammar;

$S \rightarrow A + B$

$S \rightarrow B$

$A \rightarrow a\ A$

$A \rightarrow \varepsilon$

$B \rightarrow b\ B$

$B \rightarrow \varepsilon$

i. Construct an SLR parsing table for this grammar **[15 marks]**

ii. Show behavior of parser on string a + b **[5 marks]**

SECTION B – *answer any four questions*

QUESTION TWO

a) Consider the following grammar with terminal symbols; a b +, non-terminal symbols S, A, B where S is the start symbol and productions

(P1) $S \rightarrow A + B$

(P2) $S \rightarrow B$

(P3) $A \rightarrow a\ A$

(P4) $A \rightarrow \varepsilon$

(P5) $B \rightarrow b\ B$

(P6) $B \rightarrow \varepsilon$

i. Compute FIRST and FOLLOW for this grammar. **[4 marks]**

ii. Consider the following LL(1) parsing table for a predictive table parser:

	a	b	+	$
S	P1	P2	P1	
A	P3		P4	
B		P5		P6

where Pi refers to the ith production in the above grammar. Detail how the sentence a + b would be parsed with a predictive table parser using this

table. For each step of the process give the parser action, input and stack state. **[4 marks]**

iii. Is the parsing table given in (c) the correct LL(1) predictive parsing table for this grammar? If not identify and correct the errors in the table. **[4 marks]**

b) The following grammar is clearly not LL(1),

$A \rightarrow A + B \mid A - B \mid B$
$B \rightarrow C * B \mid C / B \mid C$
$C \rightarrow (A) \mid \text{int}$

i. Transform the grammar to make it LL(1)? **[2 marks]**

ii. Construct the parsing table for a predictive parser for this grammar **[6 marks]**

QUESTION THREE

a) Outline three roles of the Parser. **[3 marks]**

b) Consider the following grammar:

E → id |
! E |
E && E |
(E)

where id, !, &&, (, and) are terminals.

i. Prove that the grammar is ambiguous by finding a string and showing its two different syntax trees. **[6 marks]**

ii. Eliminate left-recursion from the grammar. **[4 marks]**

c) Consider the following First and Follow sets:

First(S) = {b, ε}

First(T) = {b, ε}

Follow(S) = {a, $}

Follow(T) = {a, b, $}

Give the simplest grammar (fewest productions and shortest right-hand sides) that produces these sets. As usual, S is the start symbol. **[7 marks]**

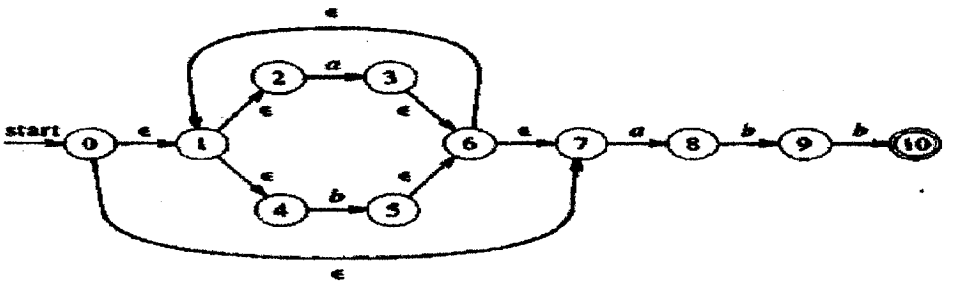
QUESTION FOUR

a) Outline three roles of the lexical analyzer. **[3 marks]**

b) Given the following regular expression; **$(a|b)^*(abb \mid a^+b)$**

Create a nondeterministic finite state machine to accept legal strings (and only legal strings), **USE THOMPSONS ALGORITHM**. **[7 marks]**

c) Consider the following NFA;



i. Convert the NFA to a DFA, show the DFA transition table and the resulting DFA diagram. **[10 marks]**

QUESTION FIVE **[20 marks]**

Consider the following simple grammar;

$G \rightarrow S\ \$$

$S \rightarrow (\ L\ ) \mid a$

$L \rightarrow L\ ,\ S \mid S$

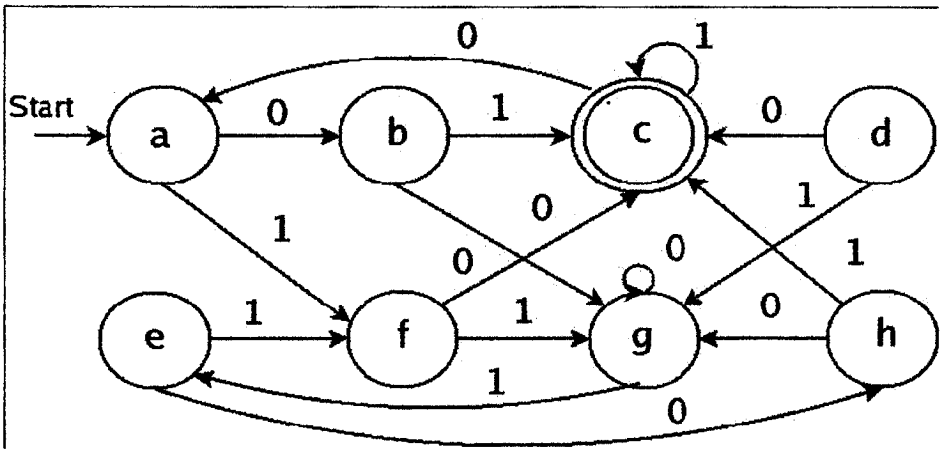
i. Construct the transition diagram of a predictive parser from the grammar

ii. Write the parsing procedures in pseudo code

iii. Trace the parser for input; ((a ,a) , (a))

QUESTION SIX

a) Minimize the following DFA **[10 marks]**



b) Consider the following grammar **[10 marks]**

G → G B
G → G N
G → ε
B → (E)
E → E (E)
E → ε
N → (L]
L → L E
L → L (
L → ε

i. Give a parse tree for the string (( ]( )

ii. Give a rightmost derivation of this same string.

iii. What is first(E) in our context-free grammar?

iv. What is follow(E)?

THE END

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF COMPUTER STUDIES

2010 SEMESTER TWO EXAMINATION

TITLE OF PAPER: COMPUTER GRAPHICS

COURSE CODE: CST4132

LEVEL: FOURTH (4th) YEAR

DATE: 26th APRIL, 2010

DURATION: THREE (3) HOURS

INSTRUCTIONS:

The examination paper is subdivided into three sections. Each section has its own set of instructions. Read through the instructions carefully before attempting any question.

Section A: 15 marks

Presented here are multiple choice questions. Each one carries one mark. Some questions have more than one answer. Any partially correct answer will be considered wrong.

1. Which of the following relates to motion dynamics
a) Deformation of a plane in flight.
b) A user flying around objects e.g. buildings.
c) Simulation of flights.
d) The viewer zooming in or out of an object.

2. Which of the following statements are disadvantages of raster graphics as compared to vector graphics are?
a) Reduced performance,
b) Real time dynamics is more computationally demanding
c) The actual image display is handled by expensive scan out logic
d) High cost

3. How does the control grid regulate light intensity in the Cathode Ray Tube?
a) By regulating electrons speed
b) By regulating the number of electrons
c) By regulating foci on the phosphorous screen
d) All the above options are correct

4. Which of the following statements about vector system's refresh rate are true?
a) It is usually at 60 frames per second
b) An increase in the complexity of an image leads to a lower refresh rate
c) Refresh rates are not applicable to vector systems
d) Refresh rate is independent of pitch complexity

5. Below is a list of an application programmer's tasks in an interactive graphics conceptual framework. Which statement does not relate to the list?
a) Creating views.
b) Creating and editing the model.
c) Handling user interactions

6. Which of the two filling rules, even-old parity rule or the none zero winding rule would produce the polygon shown in fig 1

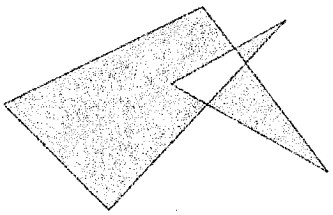


Fig 1.

a) Both even-old parity rule and the none zero winding rule
b) The even-old parity rule
c) The none zero winding rule
d) None of the above mentioned

7. Frame buffers are organized into rectangular tiles. Select the algorithm from the options listed bellow, which suffers from inefficient memory access as a result of the same organization.
a) Vector algorithms
b) Pineda's algorithm
c) Vector algorithms and Raster algorithms
d) Raster algorithms

8. Select options that are true for the data needed to represent a triangle mesh.
a) A list of triangles
b) A list of vertices
c) A list of edges
d) A normal vector

9. What would be the result of using constant triangle normal vectors for curved surfaces?
a) Curved surfaces
b) Flat surfaces
c) Dull surfaces
d) Three dimensional Surfaces

10. Which of the following are types of rigid body transformations?
a) Rotation
b) Translation
c) Uniform scale
d) Reflections

11. What kind of a transformation is presented by the equation bellow?

$$\begin{pmatrix} x' \\ y' \\ z' \\ 1 \end{pmatrix} = \begin{pmatrix} a & 0 & 0 & 0 \\ 0 & b & 0 & 0 \\ 0 & 0 & c & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ 1 \end{pmatrix}$$

a) Shear
b) Translation
c) Scale
d) Reflection

12. What is scissoring?
a) Combination of clipping and scan conversion
b) It describes a situation where a line is trivially rejected in a clip rectangle
c) Both options are correct
d) None of the above is correct

13. Why is the brute force algorithm considered to be inefficient in line clipping?
a) Clipping is done in a fixed order
b) Involves considerable calculations and testing
c) Clipping is done in a fixed order and also involves considerable calculations and testing.
d) None of the above

14. Which of the listed options is or are a disadvantage of using the parametric line drawing algorithm in scan conversion?
a) Requirement to work with real numbers,
b) Requirement to work with whole numbers
c) Divisions in the algorithm which increase completion time
d) Multiplications that are computationally demanding

15. Which of the following statements belong to the set of rules for scan converting a line?
a) The line should pass through its end points
b) The line should seem straight
c) Brightness should be uniform despite the length and angle
d) Endpoints of a line are simply an approximation

Section B: 20marks

The section contains theoretical questions. Some questions require about definitions, brief answer where as others call for a demonstration of particular algorithms.

1. Define the following terms:
   I. Computer graphics,
   II. Image processing.
   III. Update Dynamics

3 marks

2. Both Computer Graphics and Image Processing deal with computer processing of pictures but recently they have been quite separate .This is not the case anymore as the two are now overlapping. What technology can be attributed to this overlap?

1 mark

3. Draw the following systems and list their constituent parts:
   I. Vector display system.

   II. Raster display systems.

4 marks

4. The square in fig 2 below is divided in two parts by a diagonal running from the top left corner to the bottom right corner. The upper triangle labeled 1 is blue and triangle 2 is red in colour.

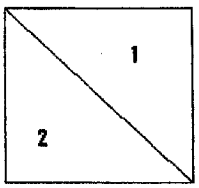


Fig 2

Which of the two colours would you use for pixels along shared edges? Explain clear and in detail the approach needed to fill such a polygon in raster graphics.

3 marks

5. Give a summary of Pineda's algorithm for filling a triangle. **3 marks**

6. What would happen if the ordering of triangle vertices in a triangle mesh is inconsistent? **2marks**

7. Write both the linear and matrix notation for an x -direction shear transformation in the 3-D coordinate system.

2marks

8. List two cases in which the Cohen-Sutherland algorithm is most efficient.

2marks

Section C: 25 marks

This section contains tasks where you are either required to do calculations or write a program. Failure to comment your code may lead to loss of marks.

1. Given a polygon with the following vertices A(0,2);B(5,6);C(7,2);D(7,0);E(4,0) . Using Pineda's inside/ outside test find the locatiòn the points X(9,6);Y(5,4);Z(2,1) with respect to the polygon

   5marks

2. Using homogenous transformations scale the point (3,5,3) by(2,1,3) about the point (2 ,4,5)

   5marks

3. Write the non-zero winding number rule algorithm in terms of program code **5marks**

4. Write a program in openGL that would draw a cube (3-D) having faces with various colors. Set the back ground colour to yellow.

   10 marks

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 112: INTRODUCTION TO HUMAN GEOGRAPHY II

TIME : Three hours

INSTRUCTIONS : Answer any FOUR questions. Candidates are advised to make use of illustrations and examples wherever appropriate. Use of a Philips University Atlas is allowed.

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1. Define culture and then describe its components with special emphasis on the 'African', 'American' and 'Chinese' world views.

2. "Knowledge is truly the mother of all other resources" (Zimmermann, 1964.:12). Comment with regard to how African countries can utilize their abundant natural resources to achieve sustainable socio-economic development.

3. Define land tenure and show how control of land has been a source of conflict in sub-Saharan Africa in recent history.

4. 'Industrial procedures in England evolved from the simple to the complex during the industrialization process'. Discuss.

5. Define modernization and then suggest ways in which Africans may achieve this process without losing all their indigenous culture.

6. Explain the 'population problem' in African countries and suggest how it can be resolved?

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 212: GEOGRAPHY OF ZAMBIA

TIME: **Three hours**

INSTRUCTIONS: Answer any **four** questions.
All questions carry **equal marks**. Use of a Philips' University Atlas is allowed. Candidates are encouraged to use illustrations wherever appropriate.

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1. Write short explanatory notes on **ALL** of the following.

   a. Forest type of vegetation in Zambia,
   b. Integrated Rural Development Programmes (IRDPs),
   c. Two types of losses incurred by NAMBOARD during the Second Republic,
   d. The five stages of Butler's life cycle theory,
   e. The World Bank's five critical components of a rural development strategy.

2. 'Zambia has abundant water resources which can be utilized for socio-economic development'. Discuss.

3. 'The Rural Non-Farm Economy (RNFE) is a viable alternative for rural development in Zambia'. Discuss.

4. Discuss the opportunities and challenges of Zambia's manufacturing industry in a liberalized economy.

5. The emergence of Zambia as a nation suggests 'unity in diversity'. Discuss this statement in relation to pre-colonial migrations.

6. Describe Zambia's agro-ecological regions and show their significance.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
INSTITUTE OF DISTANCE EDUCATION
2009 ACADEMIC YEAR DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 212: THE GEOGRAPHY OF ZAMBIA

TIME: THREE HOURS

INSTRUCTIONS: Answer question one (40%) and any other three questions. Illustrate your answers wherever possible. Use of an approved atlas is allowed.

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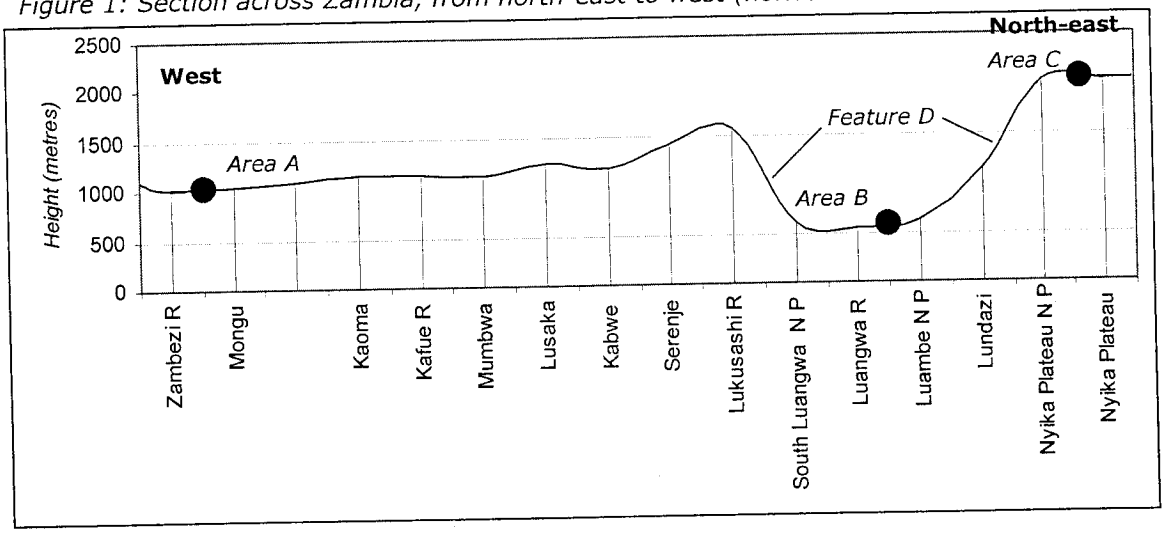
1. Figure 1 below shows a section from north-eastern to western Zambia. Study the diagram and then answer the questions that follow.

Figure 1: Section across Zambia, from north-east to west (horizontal distance not to scale)



(a) Describe the geologic systems of areas A, B and C.

(b) Explain why relief is higher in the north-eastern part of Zambia than in the western part.

(c) For relief feature D explain:

(i) how it was formed;

(ii) its climate;

(iii) its vegetation; and

(iv) its soils.

2. Discuss the social, economic and physical factors that affect cattle rearing in Zambia.

3. Discuss the economic challenges that Zambia faces as a landlocked country.

4. (a) Why is the fishing industry called 'the robber' industry?
   (b) What initiatives can the Zambian government take to ensure sustainability in the fishing industry?

5. What development strategies should Zambia embark on to meet the challenges of globalisation in the 21st century?

6. Discuss the effects of mining on the biophysical environment in Zambia.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES
DEPARTMENT OF GEOGRAPHY

GEO 272: QUANTITATIVE TECHNIQUES IN GEOGRAPHY II

FORMULAS

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1. $\bar{x} = \frac{\Sigma x_i}{n}$ OR $\bar{x} = \frac{\Sigma f x_i}{n}$

2. MODE $= L_1 + \left(\frac{\Delta_1}{\Delta_1 + \Delta_2}\right) C$

3. MEDIAN $= L_1 + \left(\frac{\frac{n}{2} - (\Sigma f)}{f \text{ median}}\right) C$

4. M.D. $= \frac{\Sigma |x_i - \bar{x}|}{n}$ OR $\frac{\Sigma f |x - \bar{x}|}{n}$

5. $S^2 = \frac{\Sigma x^2 - \frac{(\Sigma x_i)^2}{n}}{n-1}$ OR

$$S^2 = \frac{1}{n-1}\Sigma(x_i - \bar{x})^2, \quad \text{OR} \quad \sigma^2 = \frac{\Sigma f(x - \bar{x})^2}{n}$$

6. $S = \sqrt{S^2}$, OR $\sigma = \sqrt{\sigma^2}$

7. Skewness $= \frac{3(\bar{x} - \text{median})}{s}$

8. Kurtosis $= \frac{\Sigma(x_i - \bar{x})^4}{n\sigma^4}$

9. C.V $= \frac{s}{\bar{x}} \times 100$

10. $Z = \frac{x - \bar{x}}{s}$, OR $Z = \frac{x - \bar{x}}{\sigma}$.

11. $Z = \frac{\bar{x}_1 - \bar{x}_2}{\sigma_{\bar{x}_1 - \bar{x}_2}}$

25. $\sigma = S_D = \sqrt{\frac{\sum(d-\bar{d})^2}{n-1}}$

26. $U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - \sum R_1$

OR $U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - \sum R_2$

27. $Z = \frac{u-\mu_u}{\sigma_u}$

28. $\sigma_u = \sqrt{\frac{n_1 n_2(n_1+n_2+1)}{12}}$

29. $\hat{y} = a + bx$

30. $a = \bar{y} - b\bar{x}$

31. $b = \frac{\sum xy - n\bar{x}\bar{y}}{\sum x^2 - n\bar{x}^2}$

32. $r_s = 1 - \frac{6\sum d^2}{n^3 - n}$

33. $r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}}$

34. $Z = \frac{p_1 - p_2}{\sigma_{p_1 - p_2}}$

35. $\sigma_{p_1-p_2} = \sqrt{pq\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}$

36. $\frac{Z = x - np}{\sqrt{npq}}$

FORMULAE SHEET

1. $$t = \frac{|\bar{x} - \bar{y}|}{\sqrt{\frac{\left(\sum (x^2 / n_x) - \bar{x}^2\right)}{n_x - 1} + \frac{\left(\sum y^2 / n_y\right) - \bar{y}^2}{n_y - 1}}}$$

2. $$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{[n \sum x^2 - (\sum x)^2][n \sum y^2 - (\sum y)^2]}}$$

3. $$H = \frac{12}{N(N+1)} \sum \frac{R^2}{n} - 3(N+1)$$

4. $$U_x = n_x n_y + \frac{n_x (n_x + 1)}{2} - \sum r_x$$

5. $$U_y = n_x n_y + \frac{n_y (n_y + 1)}{2} - \sum r_y$$

6. $$a = \bar{y} - b\bar{x} \quad \text{or} \quad a = \frac{\sum y - b \sum x}{n}$$

7. $$b = \frac{\sum xy - n\,\bar{x}\bar{y}}{\sum x^2 - n\bar{x}^2} \quad \text{or} \quad b = \frac{n \sum xy - (\sum x)(\sum y)}{n \sum x^2 - (\sum x)^2}$$

8. $$\chi^2 = \sum \frac{(O - E)^2}{E}$$

9. $$S^2 = \frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}$$

10. $$\hat{\sigma}_W^2 = \frac{\sum_{k} \sum_{n} (x - \bar{x})^2}{N-K} \qquad \hat{\sigma}_B^2 = \frac{\sum_{k} n (\bar{x} - \bar{x}G)^2}{K-1}$$

11. $$F = \frac{\hat{\sigma}_B^2}{\hat{\sigma}_W^2}$$

12. $$r_s = 1 - \frac{6 \sum d^2}{n^3 - n}$$

13. $$S^2 = \frac{\sum_{i-j}^{k} f_j C_j^2 - \frac{\left(\sum_{i-j}^{k} f_j C_j\right)^2}{n}}{n-1}$$

14. $$\text{Mode} = L + \frac{f_m - f_1}{(f_m - f_i) + (f_m - f_2)} \times h$$

C4 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 critical value at chosen significance level.

C8 Critical Values of Pearson's Product-Moment Correlation Coefficient r

Degrees of freedom	Significance level (one-tailed) 0.05	0.025	0.01	0.005
	Significance level (two-tailed) 0.1	0.05	0.02	0.01
1	0.9877	0.9969	0.9995	0.9999
2	0.900	0.950	0.980	0.990
3	0.805	0.878	0.934	0.959
4	0.729	0.811	0.882	0.917
5	0.669	0.755	0.833	0.875
6	0.622	0.707	0.789	0.834
7	0.582	0.666	0.750	0.798
8	0.549	0.632	0.716	0.765
9	0.521	0.602	0.685	0.735
10	0.497	0.576	0.658	0.708
11	0.476	0.553	0.634	0.684
12	0.458	0.532	0.612	0.661
13	0.441	0.514	0.592	0.641
14	0.426	0.497	0.574	0.623
15	0.412	0.482	0.558	0.606
16	0.400	0.468	0.543	0.590
17	0.389	0.456	0.529	0.575
18	0.378	0.444	0.516	0.561
19	0.369	0.433	0.503	0.549
20	0.360	0.423	0.492	0.537
25	0.323	0.381	0.445	0.487
30	0.296	0.349	0.409	0.449
35	0.275	0.325	0.381	0.418
40	0.257	0.304	0.358	0.393
45	0.243	0.288	0.338	0.372
50	0.231	0.273	0.322	0.354
60	0.211	0.250	0.295	0.325
70	0.195	0.232	0.274	0.302
80	0.183	0.217	0.257	0.283
90	0.173	0.205	0.242	0.267
100	0.164	0.195	0.230	0.254

Reject H_0 if calculated value of r is greater than critical value at chosen significance level (in absolute terms).

C9 Critical Values of Spearman's Rank Correlation Coefficient r_s

Degrees of freedom	Significance level (one-tailed) 0.05	0.025	0.01	0.005
	Significance level (two-tailed) 0.1	0.05	0.02	0.01
4	1.000			
5	0.900	1.000	1.000	
6	0.829	0.886	0.943	1.000
7	0.714	0.786	0.893	0.929
8	0.643	0.738	0.833	0.881
9	0.600	0.683	0.783	0.833
10	0.564	0.648	0.745	0.794
11	0.523	0.623	0.736	0.818
12	0.497	0.591	0.703	0.780
13	0.475	0.566	0.673	0.745
14	0.457	0.545	0.646	0.716
15	0.441	0.525	0.623	0.689
16	0.425	0.507	0.601	0.666
17	0.412	0.490	0.582	0.645
18	0.399	0.476	0.564	0.625
19	0.388	0.462	0.549	0.608
20	0.377	0.450	0.534	0.591
21	0.368	0.438	0.521	0.576
22	0.359	0.428	0.508	0.562
23	0.351	0.418	0.496	0.549
24	0.343	0.409	0.485	0.537
25	0.336	0.400	0.475	0.526
26	0.329	0.392	0.465	0.515
27	0.323	0.385	0.456	0.505
28	0.317	0.377	0.448	0.496
29	0.311	0.370	0.440	0.487
30	0.305	0.364	0.432	0.478
35	0.282	0.336	0.399	0.442
40	0.263	0.314	0.373	0.413
45	0.248	0.296	0.351	0.388
50	0.235	0.280	0.332	0.368
55	0.224	0.267	0.317	0.351
60	0.214	0.255	0.303	0.335
65	0.206	0.245	0.291	0.322
70	0.198	0.236	0.280	0.310
75	0.191	0.228	0.271	0.300
80	0.185	0.221	0.262	0.290
85	0.180	0.214	0.254	0.281
90	0.174	0.208	0.247	0.273
95	0.170	0.202	0.240	0.266
100	0.165	0.197	0.234	0.259

Reject H_0 if calculated value of r_s is greater than the critical value at the chosen significance level (in absolute terms).

For degrees of freedom greater than 30 other critical values can be found from the following relationship:

$$r_s = z\sqrt{1/(n-1)}$$

where r_s is the critical value of r_s, n is the number of individuals in the data set (the degrees of freedom), and z is the appropriate critical value of a standard normal deviate (from Appendix C10). For a two-tailed test at the 0.01 level the appropriate value of z is 2.576, so the critical value of r_s with 72 degrees of freedom is:

$$2.576\sqrt{1/(72-1)} = 2.576\sqrt{0.014}$$
$$= 2.576 \times 0.119$$
$$= 0.306$$

C10 Critical Values of a Standard Normal Deviate z

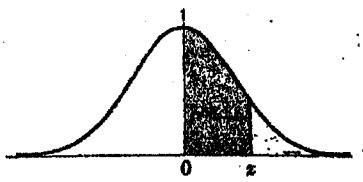
	Significance level (one-tailed) 0.1	0.05	0.01	0.005	0.001
z	1.282	1.645	2.326	2.576	3.090
−z	−1.282	−1.645	−2.326	−2.576	−3.090
	Significance level (two-tailed) 0.1	0.05	0.01	0.005	0.001
z	1.645	1.960	2.576	2.813	3.291
−z	−1.645	−1.960	−2.576	−2.813	−3.291

APPENDIX

TABLES OF CRITICAL VALUES

Appendix II

AREAS under the STANDARD NORMAL CURVE from 0 to z



z	0	1	2	3	4	5	6	7	8	9
0·0	0·0000	0·0040	0·0080	0·0120	0·0160	0·0199	0·0239	0·0279	0·0319	0·0359
0·1	0·0398	0·0438	0·0478	0·0517	0·0557	0·0596	0·0636	0·0675	0·0714	0·0754
0·2	0·0793	0·0832	0·0871	0·0910	0·0948	0·0987	0·1026	0·1064	0·1103	0·1141
0·3	0·1179	0·1217	0·1255	0·1293	0·1331	0·1368	0·1406	0·1443	0·1480	0·1517
0·4	0·1554	0·1591	0·1628	0·1664	0·1700	0·1736	0·1772	0·1808	0·1844	0·1879
0·5	0·1915	0·1950	0·1985	0·2019	0·2054	0·2088	0·2123	0·2157	0·2190	0·2224
0·6	0·2258	0·2291	0·2324	0·2357	0·2389	0·2422	0·2454	0·2486	0·2518	0·2549
0·7	0·2580	0·2612	0·2642	0·2673	0·2704	0·2734	0·2764	0·2794	0·2823	0·2852
0·8	0·2881	0·2910	0·2939	0·2967	0·2996	0·3023	0·3051	0·3078	0·3106	0·3133
0·9	0·3159	0·3186	0·3212	0·3238	0·3264	0·3289	0·3315	0·3340	0·3365	0·3389
1·0	0·3413	0·3438	0·3461	0·3485	0·3508	0·3531	0·3554	0·3577	0·3599	0·3621
1·1	0·3643	0·3665	0·3686	0·3708	0·3729	0·3749	0·3770	0·3790	0·3810	0·3830
1·2	0·3849	0·3869	0·3888	0·3907	0·3925	0·3944	0·3962	0·3980	0·3997	0·4015
1·3	0·4032	0·4049	0·4066	0·4082	0·4099	0·4115	0·4131	0·4147	0·4162	0·4177
1·4	0·4192	0·4207	0·4222	0·4236	0·4251	0·4265	0·4279	0·4292	0·4306	0·4319
1·5	0·4332	0·4345	0·4357	0·4370	0·4382	0·4394	0·4406	0·4418	0·4429	0·4441
1·6	0·4452	0·4463	0·4474	0·4484	0·4495	0·4505	0·4515	0·4525	0·4535	0·4545
1·7	0·4554	0·4564	0·4573	0·4582	0·4591	0·4599	0·4608	0·4616	0·4625	0·4633
1·8	0·4641	0·4649	0·4656	0·4664	0·4671	0·4678	0·4686	0·4693	0·4699	0·4706
1·9	0·4713	0·4719	0·4726	0·4732	0·4738	0·4744	0·4750	0·4756	0·4761	0·4767
2·0	0·4772	0·4778	0·4783	0·4788	0·4793	0·4798	0·4803	0·4808	0·4812	0·4817
2·1	0·4821	0·4826	0·4830	0·4834	0·4838	0·4842	0·4846	0·4850	0·4854	0·4857
2·2	0·4861	0·4864	0·4868	0·4871	0·4875	0·4878	0·4881	0·4884	0·4887	0·4890
2·3	0·4893	0·4896	0·4898	0·4901	0·4904	0·4906	0·4909	0·4911	0·4913	0·4916
2·4	0·4918	0·4920	0·4922	0·4925	0·4927	0·4929	0·4931	0·4932	0·4934	0·4936
2·5	0·4938	0·4940	0·4941	0·4943	0·4945	0·4946	0·4948	0·4949	0·4951	0·4952
2·6	0·4953	0·4955	0·4956	0·4957	0·4959	0·4960	0·4961	0·4962	0·4963	0·4964
2·7	0·4965	0·4966	0·4967	0·4968	0·4969	0·4970	0·4971	0·4972	0·4973	0·4974
2·8	0·4974	0·4975	0·4976	0·4977	0·4977	0·4978	0·4979	0·4979	0·4980	0·4981
2·9	0·4981	0·4982	0·4982	0·4983	0·4984	0·4984	0·4985	0·4985	0·4986	0·4986
3·0	0·4987	0·4987	0·4987	0·4988	0·4988	0·4989	0·4989	0·4989	0·4990	0·4990
3·1	0·4990	0·4991	0·4991	0·4991	0·4992	0·4992	0·4992	0·4992	0·4993	0·4993
3·2	0·4993	0·4993	0·4994	0·4994	0·4994	0·4994	0·4994	0·4995	0·4995	0·4995
3·3	0·4995	0·4995	0·4995	0·4996	0·4996	0·4996	0·4996	0·4996	0·4996	0·4997
3·4	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4997	0·4998
3·5	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998	0·4998
3·6	0·4998	0·4998	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999
3·7	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999
3·8	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999	0·4999
3·9	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000	0·5000

C3c Critical Values of U for a One-Tailed Test at the 0.01 Significance Level or a Two-Tailed Test at the 0.02 Level

n_x \ n_y	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1													0	0	0	0	0	0	1	1
2							0	1	1	1	1	2	2	2	3	3	4	4	4	5
3					0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10
4				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
5				1	2	3	4	6	7	8	9	11	12	13	15	16	18	19	20	22
6			0	1	3	4	6	8	9	11	12	14	16	17	19	21	23	24	26	28
7			1	2	4	6	8	10	11	13	15	17	20	22	24	26	28	30	32	34
8			1	3	5	7	9	11	14	16	18	21	23	26	28	31	33	36	38	40
9			1	3	6	8	11	13	16	19	22	24	27	30	33	36	38	41	44	47
10			1	4	7	9	12	15	18	22	25	28	31	34	37	41	44	47	50	53
11			2	5	8	11	14	17	21	24	28	31	35	38	42	46	49	53	56	60
12		0	2	5	9	12	16	20	23	27	31	35	39	43	47	51	55	59	63	67
13		0	2	6	10	13	17	22	26	30	34	38	43	47	51	56	60	65	69	73
14		0	3	7	11	15	19	24	28	33	37	42	47	51	56	61	66	70	75	80
15		0	3	7	12	16	21	26	31	36	41	46	51	56	61	66	71	76	82	87
16		0	4	8	13	18	23	28	33	38	44	49	55	60	66	71	77	82	88	93
17		0	4	9	14	19	24	30	36	41	47	53	59	65	70	76	82	88	94	100
18		1	4	9	15	20	26	32	38	44	50	56	63	69	75	82	88	94	101	107
19		1	5	10	16	22	28	34	40	47	53	60	67	73	80	87	93	100	107	114
20																				

Reject H_0 if calculated value of U is less than or equal to critical value at chosen significance level.

C7b Critical Values of F at the 0.05 Significance Level

Degrees of freedom for between samples variance estimate

Degrees of freedom for within samples variance estimate	1	2	3	4	5	6	7	8	9
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88

10	12	15	20	24	30	40	60	120	∞
241.9	243.9	245.9	248.0	249.1	250.1	251.1	252.2	253.3	254.3
19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.36
4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

Reject H_0 if calculated value of F is greater than critical value.

C7c Critical Values of F at the 0.01 Significance Level

Degrees of freedom for between samples variance estimate

Degrees of freedom for within samples variance estimate	1	2	3	4	5	6	7	8	9
1	4052	4999.5	5403	5625	5764	5859	5928	5982	6022
2	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66
5	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16
6	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98
7	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72
8	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91
9	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35
10	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18
27	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41

10	12	15	20	24	30	40	60	120	∞
6056	6106	6157	6209	6235	6261	6287	6313	6339	6366
99.40	99.42	99.43	99.45	99.46	99.47	99.47	99.48	99.49	99.50
27.23	27.05	26.87	26.69	26.60	26.50	26.41	26.32	26.22	26.13
14.55	14.37	14.20	14.02	13.93	13.84	13.75	13.65	13.56	13.46
10.05	9.89	9.72	9.55	9.47	9.38	9.29	9.20	9.11	9.02
7.87	7.72	7.56	7.40	7.31	7.23	7.14	7.06	6.97	6.88
6.62	6.47	6.31	6.16	6.07	5.99	5.91	5.82	5.74	5.65
5.81	5.67	5.52	5.36	5.28	5.20	5.12	5.03	4.95	4.86
5.26	5.11	4.96	4.81	4.73	4.65	4.57	4.48	4.40	4.31
4.85	4.71	4.56	4.41	4.33	4.25	4.17	4.08	4.00	3.91
4.54	4.40	4.25	4.10	4.02	3.94	3.86	3.78	3.69	3.60
4.30	4.16	4.01	3.86	3.78	3.70	3.62	3.54	3.45	3.36
4.10	3.96	3.82	3.66	3.59	3.51	3.43	3.34	3.25	3.17
3.94	3.80	3.66	3.51	3.43	3.35	3.27	3.18	3.09	3.00
3.80	3.67	3.52	3.37	3.29	3.21	3.13	3.05	2.96	2.87
3.69	3.55	3.41	3.26	3.18	3.10	3.02	2.93	2.84	2.75
3.59	3.46	3.31	3.16	3.08	3.00	2.92	2.83	2.75	2.65
3.51	3.37	3.23	3.08	3.00	2.92	2.84	2.75	2.66	2.57
3.43	3.30	3.15	3.00	2.92	2.84	2.76	2.67	2.58	2.49
3.37	3.23	3.09	2.94	2.86	2.78	2.69	2.61	2.52	2.42
3.31	3.17	3.03	2.88	2.80	2.72	2.64	2.55	2.46	2.36
3.26	3.12	2.98	2.83	2.75	2.67	2.58	2.50	2.40	2.31
3.21	3.07	2.93	2.78	2.70	2.62	2.54	2.45	2.35	2.26
3.17	3.03	2.89	2.74	2.66	2.58	2.49	2.40	2.31	2.21
3.13	2.99	2.85	2.70	2.62	2.54	2.45	2.36	2.27	2.17
3.09	2.96	2.81	2.66	2.58	2.50	2.42	2.33	2.23	2.13
3.06	2.93	2.78	2.63	2.55	2.47	2.38	2.29	2.20	2.10
3.03	2.90	2.75	2.60	2.52	2.44	2.35	2.26	2.17	2.06
3.00	2.87	2.73	2.57	2.49	2.41	2.33	2.23	2.14	2.03
2.98	2.84	2.70	2.55	2.47	2.39	2.30	2.21	2.11	2.01
2.80	2.66	2.52	2.37	2.29	2.20	2.11	2.02	1.92	1.80
2.63	2.50	2.35	2.20	2.12	2.03	1.94	1.84	1.73	1.60
2.47	2.34	2.19	2.03	1.95	1.86	1.76	1.66	1.53	1.38
2.32	2.18	2.04	1.88	1.79	1.70	1.59	1.47	1.32	1.00

Reject H_0 if calculated value of F is greater than critical value.

THE UNIVERSITY OF ZAMBIA
INSTITUTE OF DISTANCE EDUCATION

2009 ACADEMIC YEAR DISTANCE EDUCATION FINAL EXAMINATIONS

GEO 272: QUANTITATIVE TECHNIQUES IN GEOGRAPHY 11

Time: Three hours
Instructions: Answer any **four** questions. All questions carry equal marks. Use of an approved scientific calculator is allowed.

1.A village Head man noticed that Jacob, Stephen, and Mary drink castle amounting to the number of bottles as illustrated in Table 1, and disturb their fellow villagers whenever they are drunk. Consequently, he advises his indunas to counsel them. Assuming that the three data sets were randomly collected and are normally distributed would he be justified to suggest that they should be accorded equal time of counseling? Use the 0.01 one level of significance in your analysis.

Figure 1: Number of bottles of Castle drank by Jacob, Stephen and Mary

Jacob :	43,	48,	42,	60,	39,	47,	54,	47,	55,	62,	50.
Stephen:	44,	50,	41,	55,	47,	58,	49,	52,	51		
Mary:	51,	40,	50,	42,	45,	48	62,	47,	52,	49,	50.

2(A). A random sample of twenty five households in Evesdelle residential area yielded a mean household income of €1 240 per month and a sample deviation of €95 (€ means Euro)
Calculate the following :

a) the percentage of people earn more than €1 000;
b) the probability of people earning between € 900 and €1 500 and;
c) likelihood of some people earning more than €1 600.

(B). Due to Cholera out break the Ministry of Health has re-enforced the thirty five (35) Cholera centers with the following members of medical staff

Table 2: Re-enforcement numbers of medical staff to the Cholera centers.

60	38	24	48	68	30	42
86	66	30	112	36	16	30
54	20	20	48	30	34	24
84	04	14	20	34	10	24
40	44	30	08	40	46	31

Source: Hypothetical.

Establish whether or not the distribution was skewed.

3. Two road contractors, with the same capacities were contracted to tar two roads in Mazombwe and Mulikita areas which have similar physical attributes. The contractors' performance was as illustrated in Table 3. Which contractor would stand a better chance of winning another contract at a later time? Aim at 99% accuracy in your analysis after assuming that each data set provided in Table 3 has a skewness of 0?

Table 3: Roads tarred (in Kilometres per month) by two different road contractors in Mazombwe and Mulikita aeas

	Mazombwe (km per month)	Mulikita (km per month)///
January	15	10
February	12	28
March	17	30
April	16	25
May	20	45
June	30	55
July	25	67
August	12	77
September	30	65
October	10	88
November	23	67
December	10	10

Source: Hypothetical.

6. Study Figure 1 (attached) and

a) determine the simple regression equation;

b). define your simple linear regression equation;

c) plot the line of best fit and

d) find the co-efficient of determination and explain what it means based the dependent and independent variables.

END OF EXAMINATION

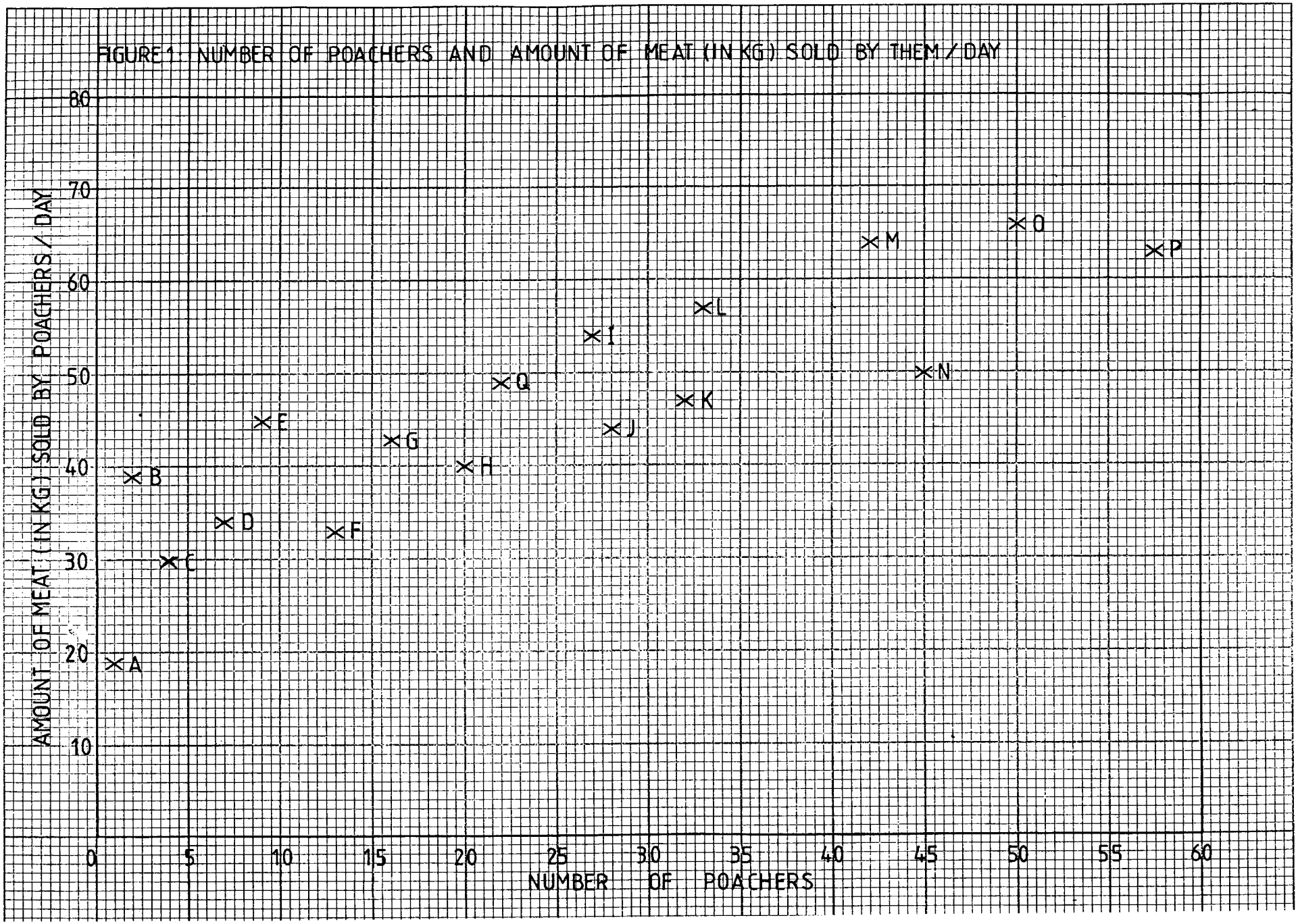


FIGURE 1: NUMBER OF POACHERS AND AMOUNT OF MEAT (IN KG) SOLD BY THEM / DAY
AMOUNT OF MEAT (IN KG) SOLD BY POACHERS / DAY
NUMBER OF POACHERS
0
5
10
15
20
25
30
35
40
45
50
55
60
10
20
30
40
50
60
70
80
A
B
C
D
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UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 492- NATURAL RESOURCE ECONOMICS

TIME: 3 HOURS

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

Use of an approved calculator is allowed.

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1. Write short notes on **ALL** of the following:

(a) Excludability and Rivalry in Consumption

(b) Rationale for Discounting

(c) Preventive Expenditure Method of valuating environmental resources without a market price.

(d) Sources of inefficiencies in forest management.

(e) Major weaknesses of the Contingent Valuation Method

2. An environmental Non Governmental organization has submitted a project brief to the Environmental Council of Zambia requesting permission to develop an area into a game ranch. If allowed to develop, it will need an initial investment of ZMK 5 million and ZMK 200,000 annual maintenance costs. It is expected to earn ZMK1 million annually. This area is currently occupied by 200 farming households. These households currently earn ZMK500, 000 each annually. Their representatives petition the government that it should let the households continue farming there, and help them with farming inputs so that they could increase their annual production to ZMK 1 million per household. The purchase of these farming inputs would cost the government a total of ZMK 800,000. What would you recommend and why? (Assume n= 20 years and r = 10%).

3. 'Economic incentives (carrots) are better than government controls (sticks) in pollution control'. Discuss using taxes and standards as examples.

4. Select and discuss a method commonly used by natural resource economists for valuating recreational sites.

5. Discuss the assertion that "…..there is no physical or economic reason why human resourcefulness and enterprise cannot forever continue to respond to impending shortages of natural resources" (Simon, 1986: 82).

6.

(a) Using Figure 1 for illustration, show why the economically efficient fisheries harvest level is different from the ecologically important Maximum Sustainable Yield (MSY).

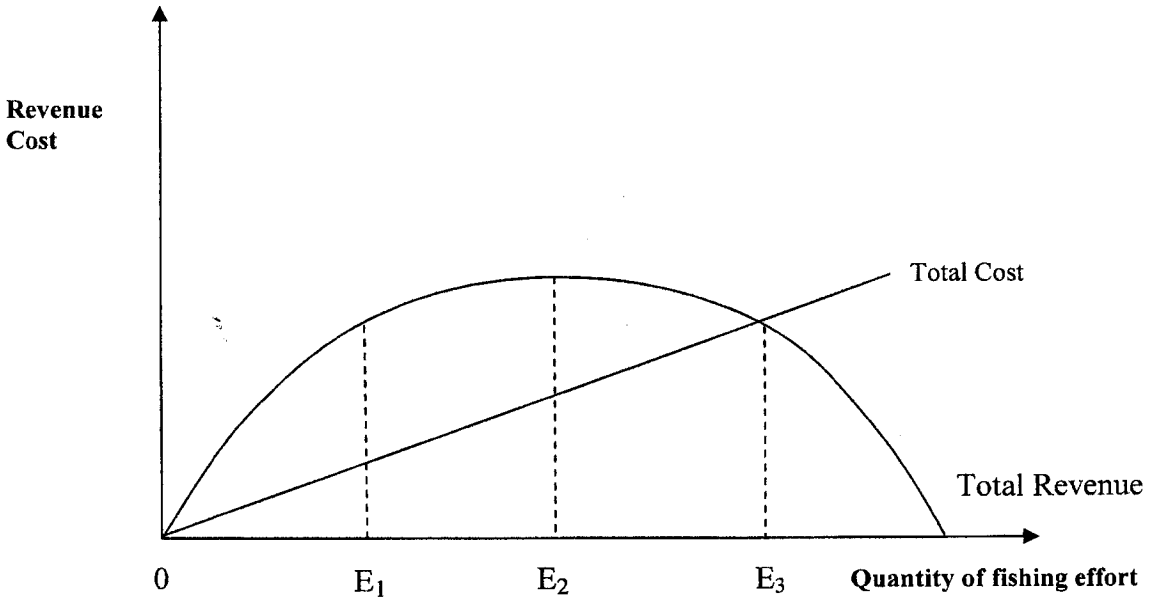

Figure 1 Efficient Management of a Fishery

(b) Why are property regimes important in fisheries management?

END OF EXAMINATIONS

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL DEFERRED EXAMINATION

GEO 912: GEOGRAPHY OF MIGRATION AND REFUGEES

TIME: **THREE HOURS**
INSTRUCTIONS: **Answer any FOUR questions.**
All questions carry equal marks

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1. Distinguish between a refugee and a mere migrant.

2. Discuss Article 1, 2, 3 and 4 of the 1969 OAU Refugee Convention.

3. Lee's (1966) model of migration is irrelevant in Zambia today. Discuss.

4. Examine any six crucial actors in a refugee camp in terms of their (refugees) survival in the tripartite approach.

5. 'There have been disparities in international assistance to refugees in many parts of the world'. Discuss this statement with reference to Zambia, the United States of America and any other country of your choice.

6. Assess how the interaction of man and the state (or the social organization) is important in determining migratory forces, class, type of selectivity and destinations of migrants in the contemporary world.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 922: GEOGRAPHY OF REGIONAL PLANNING AND DEVELOPMENT

TIME: Three Hours

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

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1. Discuss the usefulness of the growth pole theory in regional development planning.

2. Suppose you were hired as a Regional Planner in one of Zambia's regional planning units. As part of the regional planning process, your planning unit has just finished carrying out a Regional Situation Analysis and you are tasked to develop a comprehensive regional development plan. Explain how you would use the information from the Regional Situation Analysis to feed into the next steps of the planning process in order to deliver a complete plan.

3. Discuss the assertion that decentralisation challenges centrist modes of development planning and delivers benefits to local communities.

4. 'As globalisation advances, regions tend to be more concerned with global competitive advantage rather than comparative advantage'. Discuss.

5. Compare and contrast the conservative and liberal perspectives on economic development.

6. Examine regional inequalities and uneven development in Zambia.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 932: URBAN GEOGRAPHY

TIME : Three hours
INSTRUCTIONS: Answer any **four** questions
All questions carry equal marks.
Candidates are encouraged to use illustrations wherever appropriate.

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1. Write short explanatory notes on **all** of the following:
   a) Urban mobility
   b) Inefficiencies of the urban property market
   c) Wirth's notion of 'urbanism'
   d) Risk accumulation in cities
   e) The immediate external causes of urban poverty

2. Evaluate the policy strategies which have been advanced by the Zambian government since independence in an attempt to curb the urban housing problem.

3. Discuss the paradigms and theories which have been applied to urban geography in its development as a field of study.

4. "The net flow of ecosystem services is invariably into rather than out of urban systems" (McGranahan and Marcotullio, 2007: 805). Discuss.

5. Discuss the processes and outcomes of rural-urban migration in Zambia.

6. Examine the Stren and Halfani's (2001) 'anatomy of urban decline' in African cities following the 1980s global recession.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 952: GEOGRAPHICAL HYDROLOGY

TIME: **Three hours**

INSTRUCTIONS: Answer any **FOUR** questions.

All questions carry equal marks. Candidates are advised to make use of illustrations and examples wherever appropriate.

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1. Write short explanatory notes on **ALL** of the following:

   a) Infiltration capacity
   b) Three baseflow separation methods
   c) Four methods of soil moisture measurement
   d) Merits and demerits of the Neutron Probe for soil moisture measurement
   e) Four methods of flood magnitude assessment

2. Outline and explain the major characteristics of a river catchment and their relevance to hydrological studies.

3. Discuss the main physical aspects of interception and the appropriate methods used in the measurement of its various components.

4. With the use of a case study in Zambia, discuss the principles of a multipurpose river basin development project.

5. Assess the impact and implications of extreme hydrological event occurrence in the past decade in Zambia.

6. Discuss the impacts of land use on hydrological regimes.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 955: GEOMORPHOLOGY

TIME: Three hours

INSTRUCTIONS: Answer any FOUR questions.

All questions carry equal marks. Candidates are advised to make use of illustrations and examples wherever appropriate.

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1. Write short explanatory notes on ALL of the following:

   a) Geomorphological system
   b) Palaeoenvironmental reconstruction
   c) Cataclastic metamorphism
   d) Types of earthquake seismic waves
   e) Etchplanation

2. Outline and describe the geomorphological legend of Zambia.

3. With the use of diagrams, describe the typical bed form sequences in the lower and upper flow regimes for alluvial sand bed channels.

4. Define a *dambo* and discuss typical characteristics of *dambos* and how their existence is threatened by human activities in tropical Africa.

5. Discuss the factors influencing laterization and duricrust formation.

6. Discuss the value of geomorphological studies in the understanding of magnitudes and impacts of climate change on earth.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS
GEO 972 SATELLITE REMOTE SENSING AND GIS

TIME : Three Hours
INSTRUCTIONS : Answer question ONE. and any other THREE questions. All questions carry equal marks.

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1. Write short explanatory notes on **ALL** of the following:
   (a) Training site.
   (b) Ground Control Points.
   (c) Confusion matrix.
   (d) Spectral signature.
   (e) Digital Image Analysis

2. Define spatial resolution and outline a minimum of five (5) of its determinants.

3. 'Image segmentation processes are based on one of two basic properties of the pixels' grey level values: discontinuity and similarity'. Explain.

4. The science of Satellite Remote Sensing revolves, in part, around the physics of the electromagnetic spectrum; transmittance, absorptance, and reflectance; spectral signatures; and resolution. Use these concepts to briefly show how satellite remote sensing is used to infer data and information about the nature and properties of an object, or surface/area.

5. 'The data acquisition methods of remote sensing implicitly involve at least one level of indirection'. Elucidate.

6. Evaluate the statement that 'the coincidence of field work and image acquisition is essential in dynamic environments such as the wet and dry tropics'.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 975 - CARTOGRAPHY

TIME: Three hours
INSTRUCTIONS: Any four questions
All questions carry equal marks.
Candidates should use diagrams and examples wherever relevant.

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1. Write short explanatory notes on ALL of the following:

   a) Scribing tools
   b) A colour proof
   c) A developable surface
   d) Semantic accuracy in mapping
   e) Qualitative line symbols

2. Explain the steps that you may take in compiling and fine drawing a thematic map of your choice.

3. 'Representation of diverse geographic data in map form is facilitated by visual variables'. Explain.

4. What are the main differences between the Universal Transverse Mercator (UTM) grid system and the Geographic Reference system?

5. Explain what map generalization is and when it is required.

6. Discuss the view that 'Computer Aided Cartography (CAD) is never meant to supersede conventional cartography'.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

Department of Mathematics & Statistics

SECOND SEMESTER FINAL EXAMINATIONS

M112—MATHEMATICAL METHODS II-A

April, 19 2010

Time allowed : THREE(3) HOURS

Instructions : There are seven(7) questions. Answer **ANY FIVE (5)** questions. All questions carry equal marks. Show all your working to earn full marks.

CALCULATORS ARE NOT ALLOWED

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1. (a) Evaluate the following binomial expressions (if possible):

   (i) $\binom{-\frac{1}{3}}{3}$

   (ii) $\binom{101}{98}$

   (b) (i) Prove by mathematical induction that $(2n+1)^2 - 1$ is divisible by 8 for all positive integers n.

   (ii) Solve the equation $4(1 + 10^{5x}) = 9$ for real x.

   (c) Find the term independent of x in the expansion of $(x - \frac{3}{x^2})^{18}$, without evaluating the binomial coefficient.

2. (a) Evaluate the following limits, if they exist.

(i) $\lim_{x\to -1} \dfrac{x^2+x}{x^2-x-2}$ (ii) $\lim_{x\to\infty} \dfrac{6x-7}{2x+100^9}$.

(b) (i) Express the following as a single logarithm ;

$\log_3 5 + 5\log_3 2 - 3\log_3 3$.

(ii) Evaluate the following integral: $\int_0^{\frac{\pi}{4}} \cos x \sin^4 x dx$.

(c) Prove by mathematical induction that for all natural numbers $n \geq 1$,

$$2+6+18+\ldots\ldots+2(3^{n-1}) = 3^n - 1.$$

3. (a) Sketch the graph of

$$f(x) = \begin{cases} x^2 & x < 2 \\ 3 & x = 2 \\ 3x-2 & x > 2. \end{cases}$$

Hence identify each of the following limits:

(i) $\lim_{x\to 2^-} f(x)$ (ii) $\lim_{x\to 2^+} f(x)$ (iii) $\lim_{x\to 2} f(x)$.

(iv) Is f continuous at $x = 2$?

(b) Evaluate the following integrals:

(i) $\int x^3 \ln x dx$

(ii) $\int_0^1 x(2x-1)^{20} dx$.

(c) Solve the equation $z^3 + 1 = -i$ and display the solutions on the Argand diagram.

4. (a) (i) On the same axes, sketch the curves with equations $y = 12$ and $y = x^2 - 4$.

(ii) Hence find the area of the finite region enclosed by the curves.

(b) (i) Express

$$\frac{5x^2+20x+6}{x^3+5x^2+6x}$$ into partial fractions.

(ii) Hence evaluate

$$\int_1^2 \frac{5x^2+20x+6}{x^3+5x^2+6x} dx.$$

(c) Given that $y = f(x) = \frac{1}{\sqrt{x}}$, find $\frac{dy}{dx}$ from first principles.

5. (a) (i) Express the complex numbers $z = \sqrt{3} - i$ and $w = 1 + i\sqrt{3}$ in the polar form.

(ii) Hence express

$$(1 + \sqrt{3}i)^{25}(\sqrt{3} - i)^2$$

in the form $a + ib$ where a and b are real.

(b) Solve the equation $\log_3(2 - x) = 3$ for real values of x.

(c) (i) Find $\frac{dy}{dx}$ given that $y = \sqrt{2x - 1}\sin^{-1}(2x + 2)$.

(ii) Evaluate the following indefinite integral:

$\int e^{2\sin x}\cos x dx$.

6. (a) Use a suitable binomial expansion to evaluate $\sqrt{23}$, correct to four decimal places.

(b) The equation of the curve is

$$y = \cot x - 8\cos x, \quad 0 < x < \pi.$$

Find the coordinates of the points on the curve where $\frac{dy}{dx} = 0$.

(c) Find the determinant of the matrix

$$A = \begin{pmatrix} 5 & -3 & 10 \\ 6 & 1 & 0 \\ -5 & 2 & 2 \end{pmatrix}.$$

7. (a) Let $A = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}$. Find A^2, A^3, A^4, and hence write a general formula for A^n for n any positive integer.

(b) (i) Find the exact value of $\tan[\cos^{-1}(\frac{1}{3})]$.

(ii) Let $A = \begin{pmatrix} 1 & 2 & 1 \\ 3 & 0 & 2 \end{pmatrix}$ and $B = \begin{pmatrix} 1 & 1 & -2 \\ -2 & 2 & 2 \end{pmatrix}$. Find BA^TB, and determine its order.

(c) Given the matrices $A = \begin{pmatrix} 0 & 3 & 5 \\ 2 & 0 & -1 \\ 4 & 7 & 0 \end{pmatrix}$ and $B = \begin{pmatrix} 5 & -3 & 10 \\ 6 & 0 & -1 \\ -5 & 7 & 0 \end{pmatrix}$, find $(AB)^T$.

END.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009 ACADEMIC YEAR SECOND SEMESTER FINAL EXAMINATIONS

GEO 995: ENVIRONMENT AND NATURAL RESOURCES MANAGEMENT I

Time: Three hours

Instructions: Answer any four questions. All questions carry equal marks. The use of approved electronic calculators is allowed.

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1. For each of the following pairs of concepts, provide two distinctions.
   a. Ecological density and crude density.
   b. Physiological natality and ecological natality.
   c. Biotic potential and environmental resistance.
   d. Exponential population growth model and logistical growth model.
   e. K-selected growth forms and r-selected growth forms.

2. Table 1 below, shows some hypothetical cohort data for an animal endemic to Zambia. A Consultant has advised the Zambia Wildlife Authority (ZAWA) to seek measures that would increase fecundity and population of this endemic animal. However, ZAWA has argued against the advice. You are required to analyse the data and answer the following questions. Answers to calculations must be correct to 3 decimal places.

Table 1. Cohort data for an animal endemic to Zambia

Age (Years)	Number of Individuals	Survivorship	Fecundity	Realised Fecundity
0	100	1.00	0.000	0
1	100	1.00	0.000	A
2	98	0.98	0.000	B
3	98	0.98	0.115	C
4	91	0.91	0.037	D
5	72	0.72	0.046	E
6	38	0.38	0.051	F
7	11	0.11	0.000	G
8	1	0.01	0.077	H
9	0	0.00	0	0

Source: Hypothetical.

   a. From Table 1, calculate the missing values of realised fecundity (from A to H).
   b. Calculate the net reproductive rate R_o and interpret your results.
   c. How many animals would be produced by this cohort of 100 individuals over their lifetimes? Show your work.
   d. Given that the generation time is 4.5 years, calculate the intrinsic rate of increase (r).
   e. From your calculations, do you think that ZAWA is justified with its refusal? Give reasons for your answer.

3. Explain five (5) environmental consequences of high input tropical agricultural systems.

4. Explain the negative effects of weeds on agricultural areas and Identify situations that encourage the spread of weeds.

5. Explain Integrated Pest Management (IPM) is, and how it can be applied in overcoming the problem of pesticide treadmill.

6. Discuss the ecological importance of tropical rainforests and any five problems that adversely affect their normal functioning.

End of Examination

THE UNIVERSITY OF ZAMBIA
Directorate of Distance Education

2009/2010 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M112: Mathematical Methods IIA

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS : Answer any **Five** (5) questions from this paper
Omission of essential working may result in loss of marks
Calculators and Mathematical tables are **NOT** allowed in this paper

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1. (a) Let $A=\begin{pmatrix}2 & -1 & 3\\ 1 & 3 & 1\end{pmatrix}$, $B=\begin{pmatrix}5 & 2\\ 1 & -3\\ 1 & 0\end{pmatrix}$ and $C=\begin{pmatrix}2 & 7 & 0\\ -1 & 1 & 2\\ -1 & -3 & 1\end{pmatrix}$ Find

(i) $3A-B^T$ (where B^T is the transpose of B)

(ii) AC

(b) (i) Express $\dfrac{2}{(1-x)(3-x)}$ into partial fractions.

(ii) Hence find the first four terms in the expansion of $\dfrac{2}{(1-x)(3-x)}$ in ascending powers of x

(iii) Determine the range for which your expansion in (ii) is valid.

2 (a) (i) Let $S_n=1-2+3-4+5-6+.....+(-1)^{n+1}n$. Find S_{10} and S_{15}.

(ii) Prove using mathematical induction that

$1+2+3+4+.....+n=\dfrac{1}{2}n(n+1)$ for every positive integer n.

(b) (i) A circle with center at $\left(2\,,\,\dfrac{11}{2}\right)$ passes through the point $(6\,,\,4)$.

Find the equation of the circle and find also the equation of the tangent to the circle at the point $(6\,,\,4)$.

(ii) Given that the two straight lines $y+kx+3=0$ and $(k-1)y+x-5=0$ are parallel, find possible values of k.

3. (a) (i) Find the third term and the term independent of x in the Binomial expansion of $\left(x+\frac{1}{2x}\right)^8$

(ii) Expand $(1-x)^{\frac{1}{2}}$ in ascending powers of x up to and including the term containing x^3. By substituting $x = 0.2$ in your expansion find the approximate value of $\sqrt{0.8}$ to 2 decimal places.

(b) (i) Express the complex number $z = 1+i\sqrt{3}$ in the form $r(\cos\theta + i\sin\theta)$. Hence find the squareroot of z.

(ii) Simplify $\frac{\cos 5\theta + i\sin 5\theta}{(\cos\theta - i\sin\theta)^2}$

4. (a) Evaluate the following integrals

(i) $\int \cos\frac{x}{3}dx$

(ii) $\int xe^{-x}dx$

(iii) $\int 3x\sqrt{x^2+2}dx$

(b) Let $f(x) = ax^3 + bx^2 - 2x + 1$. Given that the critical values of f(x) are $x = -1$ and $x = 2$,

(i) Find the value of a and the value of b.

(ii) Determine the intervals where the function is increasing and where it is decreasing.

(iii) Hence sketch the curve of f(x).

5. (a) Let $M = \begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & -1 \\ 1 & -2 & 3 \end{pmatrix}$

(i) Find the inverse of the matrix M

(ii) Hence or otherwise solve the system of equations

$x + y + z = 2$

$x + y - z = -3$

$x - 2y + 3z = 0$

(b) A parabola with the vertex at the origin passes through the point $P(-1, 4)$ The x – axis is the axis of symmetry of the parabola.

(i) Write down the equation of the parabola.

(ii) Sketch the parabola.

(iii) Find also the equation of the normal to the parabola at P.

6. (a) Let $\mathbf{A} = 3\mathbf{i} + 4\mathbf{j}$ and $\mathbf{B} = \mathbf{i} - 2\mathbf{j} + 3\mathbf{k}$ be two vectors.

(i) Find the cosine of the angle between the vectors **A** and **B**.

(ii) Find a unit vector perpendicular to both vector **A** and vector **B**.

(iii) Calculate also the area of the parallelogram determined by the two vectors **A** and **B**

(b) (i) Sketch the curve $y = \frac{1}{3}x^2$ for values of x in the interval $[-3, 6]$

(ii) Calculate the area bounded by the curve $y = \frac{1}{3}x^2$, the x – axis and the lines $x = -2$ and $x = 3$.

UNIVERSITY OF ZAMBIA

UNIVERSITY SECOND SEMESTER EXAMINATIONS
APRIL - 2010

MATHEMATICS M114 – MATHEMATICAL METHODS II B

INSTRUCTIONS: Attempt any five (5) questions. You are required to show all your working for full credit. Calculators are not allowed.

TIME ALLOWED: ~~Answer All Questions.~~ Three Hours

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1. (a) (i) State the period and amplitude of the function $f(x) = \cos 2x$.

(ii) Sketch the curves of $f(x) = \cos 2x$, $g(x) = 7\cos x$ and $h(x) = 7\cos x + 3$ on the same plot.

(iii) Mark the points of intersection of curves $f(x)$ *and* $h(x)$ on your graph without specifying them.

(iv) Find all solutions of the equation $\cos 2x = 7\cos x + 3$ for $0 \leq x \leq 360°$.

(b) Consider a parallelogram $ABCD$ in which $\overrightarrow{AB} = \vec{a}$ and $\overrightarrow{AD} = \vec{b}$

(i) Find $\overrightarrow{AC}$ and $\overrightarrow{BD}$ in terms of $\vec{a}$ and $\vec{b}$.

(ii) Assuming scalar product of vectors distributes addition, show that $(\vec{a} + \vec{b}).(\vec{b} - \vec{a}) = |\vec{b}|^2 - |\vec{a}|^2$

(iii) If $|\vec{b}| = |\vec{a}|$ in (ii), what would you conclude for parallelogram $ABCD$?

(c) Find the solution of the differential equation $(1 + \cos x)\,dy + \sin x\,dx = 0$, given that $y = 0$ at $x = \frac{\pi}{2}$

2. (a) Find $\frac{dy}{dx}$ given that:

(i) $y = x\sin x^2$

(ii) $y = x\sin^2 x$

(iii) $y = \frac{\sqrt{x^2+1}}{x}$

(b) Consider the function $f(x) = \frac{x}{1+x^2}$:

(i) Show that f is an odd function

(ii) Find the intervals on which the graph of f is increasing and/ or decreasing.

(iii) Find the intervals on which the graph of f is concave up and/ or down.

(iv) Compute $\lim_{n\to\infty} \frac{x}{x^2+1}$

(v) Find horizontal asymptotes to the curve if there is any

(vi) Sketch the graph of $f(x)$.

(vii) Find the area bounded by the curve $f(x)$, the x −axis and the ordinates $x = -1$ and $x = 1$

(c) A capacitor is discharging with a growth factor of 0.5 per second. Let I_0 represent the charge at $t = 0$ (initial charge) and $I(t)$ denote the charge after t seconds.

(i) Write down the charge after 1 second, 2 seconds and t seconds.

(ii) Find the time when the charge will be $\frac{1}{8}$ of the initial change.

3. (a) (i) Sketch the graph of $y = e^{-x}, x \geq 0$

(ii) Sketch the graph of $y = -e^{-x}, x \geq 0$ and state the horizontal asymptote to the curve y

graph

(iii) Draw the of $y = 1 - e^{-x}, x \geq 0$ indicating the point where the graph cuts the y −axis

(iv) Find the area bounded by the curve $y = 1 - e^{-x}$, the x −axis and the ordinate $x = 1$

(b) Evaluate the following integrals:

(i) $\int \frac{\sec^2 x}{1+\tan x} dx$

(ii) $\int \frac{\sec^2 x}{1+\tan^2 x} dx$

(iii) $\int \cos^3 t \, dt$

(c) (i) expand $\sqrt{1+x}$ as far as the term in x^3

(ii) Can you approximate $\sqrt{50}$ by writing $\sqrt{50} = \sqrt{1+49}$ and using expansion of part (i). Explain.

4. (a) (i) Find r and α such that $\cos\theta - \sin\theta = r\cos(\theta + \alpha)$

(ii) Find the maximum value of $f(\theta)$ where $f(\theta) = \cos\theta - \sin\theta$ and find θ at which $f(\theta)$ is maximum

(b) (i) Given the points $A(2,0,0)$, $B(0,1,1)$ and $C(1,2,1)$, find the area of the triangle ABC

(ii) Show that the vectors $\vec{U} = 2i - j + k$ and $\vec{V} = -i + j + 3k$ are perpendicular to each other

(iii) Find the work done by the force $F = 3i + j + k$ in moving an object from $A(2,0,0)$ to $B(2,1,1)$.

(c) The height in meters, of a rocket t minutes after blast-off is given by $h(t) = \frac{1}{4}t(24t - t^3)$.

(i) Find the velocity of the rocket at time t.

(ii) Find the maximum velocity.

5. (a) Given $\left(2x - \frac{1}{x^2}\right)^5$

(i) State the r^{th} term in the binomial expansion of the above expression

(ii) Find the coefficient of the term in $\frac{1}{x}$ in the binomial expansion of the above expression.

(b) Evaluate the following integrals:

(i) $\int_0^{\pi/2} x \sin 2x \, dx$

(ii) $\int \frac{x+2}{x^2+1} dx$

(iii) $\int \frac{x+2}{x^2-1} dx$

(c) (i) Sketch the graphs of $f(x) = \log_{\frac{1}{2}} x$ and $g(x) = \left(\frac{1}{2}\right)^x$ on the same plot

(ii) Find values of x which satisfy the inequality $\log_{\frac{1}{2}} x > \log_{\frac{1}{2}} 2$

(iii) Write the following as a single term: $2 \ln x + \ln 5 - \ln 3 \log_2 x$

6. (a) given matrix $A = \begin{pmatrix} -2 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & \frac{1}{2} \end{pmatrix}$, find the following:

(i) $det\, A$

(ii) A^{-1}

(iii) A^2 and A^3

(iv) Prove the following by mathematical induction:

$A^n = \begin{pmatrix} (-2)^n & 0 & 0 \\ 0 & (5)^n & 0 \\ 0 & 0 & \left(\frac{1}{2}\right)^n \end{pmatrix}$ where n is a positive integer.

(b) (i) The volume of a spherical balloon is $V = \frac{4}{3}\pi r^2$, where r is the radius. If $r = 5$ and $\frac{dr}{dt} = 2$ at time $t = 1$, find $\frac{dv}{dt}$ at that instant. State if the balloon is expanding or contracting

(ii) The curve $x^2 + xy + y^2 = 3$ has two tangents at $x = 1$. Find the equations of these two tangents.

(c) Given the function $f(x) = arc \sin x$

(i) State the domain and range of f

(ii) Find values of $arc \sin 1$, $arc \sin -\frac{\sqrt{3}}{2}$ and $arc \sin \left(\frac{1}{2}\right)$

(iii) Find $\frac{d}{dx}(arc \sin x)$

(iv) Using your formula of part (iii), find $\frac{d}{dx}(arc \sin x^2)$

END OF EXAMINATION

The University of Zambia
School of Natural Sciences
Department of Mathematics & Statistics

2009/10 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M212 – MATHEMATICAL METHODS IV

INSTRUCTIONS:
1. Answer any **Five (5)** of the seven Questions.
2. All questions carry equal marks.
3. Show all essential working to obtain full marks.
3. Indicate the question number of each question attempted on the cover of the main answer book.

TIME ALLOWED: **Three (3)** hours.

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1. (a) $L_1 : x = 3 + 2t,\ y = 2 - t,\ z = 1 + t$ and $L_2 : x = 4 - s,\ y = -2 + 3s,\ z = -2 + 2s$ are parametric equations of two lines in space. Show that the two lines intersect.

Hence, find

(i) their point of intersection

(ii) the symmetric equation of the line which is perpendicular to both lines L_1 and L_2 and passes through their point of intersection.

(b) Find the shortest distance between the lines

$$L_3 : \frac{x-1}{2} = \frac{y-2}{3} = \frac{z+1}{-1} \text{ and } L_4 : \frac{x-1}{3} = \frac{y+1}{-2} = \frac{z-2}{1}.$$

(c) Find the vector equation of the straight line which passes through the point $(3,-1,6)$ and is perpendicular to the plane

$$2x + y - z = 3.$$

2. (a) (i) Given that $f(t) = (5t-1)\mathbf{i} + t^2\mathbf{j} + 4t\mathbf{k}$, calculate the integral

$$\int_0^3 f(t)dt .$$

(ii) Given that $\mathbf{R}'(t) = (3t+2)\mathbf{i} - t^2\mathbf{j}$ and $\mathbf{R}(0) = 5\mathbf{i} + 2\mathbf{j}$, find $\mathbf{R}(t)$.

(b) A space curve is given by

$$\mathbf{R}(t) = 3t^2\mathbf{i} + 2t^3\mathbf{j} + 3t\mathbf{k},$$

Find its

(i) length from $t = 0$ to $t = 2$

(ii) principal unit normal vector **n** at $t = 1$

3. (a) Use the definition of limits to prove that $\lim_{(x,y)\to(2,-3)} (x - 7y) = 23$.

(b) If $w = f(u, v)$ where $u = \gamma\cos\psi$ and $v = \gamma\sin\psi$, prove that

$$\left(\frac{\partial w}{\partial u}\right)^2 + \left(\frac{\partial w}{\partial v}\right)^2 = \left(\frac{\partial w}{\partial \gamma}\right)^2 + \frac{1}{\gamma^2}\left(\frac{\partial w}{\partial \psi}\right)^2.$$

(c) Solve the differential equation

$$\frac{dy}{dx} - \frac{1}{x}y = x^3.$$

4. (a) (i) Given $f(x,y,z)=\frac{xy}{\sqrt{z}}$, find all first order partial derivatives at (3,2,9).

(ii) Use (i) to approximate the number

$$\frac{(3.03)(1.99)}{\sqrt{8.95}}.$$

(b) The total resistance R of two resistors connected in parallel is

$$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}.$$

Use the total differential to approximate the change in R as R_1 is increased from 10 ohms to 10.5 ohms and R_2 is decreased from 15 ohms to 13 ohms.

(c) Find the first three terms of the Maclaurin's series solution of the differential equation

$$y''+y'+2y=0.$$

5. (a) (i) Find the first partial derivatives $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$ of the function

$$f(x,y)=xy^2e^{x^2-y}.$$

(ii) If $w=\ln(xy-z)$, $x=s^2t$, $y=3s+t^2$, $z=s-t$, use the chain rule for partial derivatives to find $\frac{\partial w}{\partial t}$ when $s=1$ and $t=2$.

(b) Show that the following differential equation is exact:

$$(x-y\cos x)dx-\sin x dy=0.$$

Hence, find its general solution.

(c) Solve the following initial value problem:

$$(x^2-y^2)dx-3xydy=0,\ y(1)=0.$$

6. (a) By eliminating the constants A and B, find a differential equation whose general solution is

$$y = A\cos 2x + B\sin 2x .$$

(b) Solve the following differential equation:

$$y''+5y'+6y = 0,\ y(0) = 1,\ y'(0) = 2 .$$

(c) Find the general solution of the following differential equation :

$$y''+3y'+y = 9 + 2x - 2x^2 .$$

7. (a) Find the equation of the plane which passes through the points

$$P_1(1,3,-1),\ P_2(2,1,0) \text{ and } P_3(-1,2,-2) .$$

(b) Find the general solution of the following differential equation:

$$x\frac{d^2y}{dx^2} + \frac{dy}{dx} + x = 0 .$$

(c) Find the relative extrema of the function

$$f(x,y) = -x^3 + 4xy - 2y^2 + 1 .$$

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
DEPARTMENT OF MATHEMATICS AND STATISTICS

SEMESETER II EXAMINATIONS - 2010
DISTANCE EDUCATION
M212 - MATHEMATICAL METHODS IV

INSTRUCTIONS:
1. Answer any five (5) questions.
2. All questions carry equal marks.
3. Show all the necessary work to earn full marks.
4. Write down the questions attempted on the front page of the main booklet.
5. Use of calculators is not allowed.

TIME ALLOWED: Three (3) hours.

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1 (a) (i) Determine whether the points $P(1,-2,3)$, $Q(2,1,0)$ and $R(4,7,-6)$ lie on the same straight line.

(ii) Find the projection of **u** onto **v** for the vectors $\underline{u} = 3i - 5j + 2k$ and $\underline{v} = 7i + j - 2k$

(b) (i) Find the volume of the parallelepiped having $\underline{u} = 3i - 5j + k$, $\underline{v} = 2j - 2k$ and $\underline{w} = 3i + j + k$ as adjacent edges.

(ii) Find a set of parametric equations of the line that passes through the points joining $P(-2,1,0)$ and $Q(1,3,5)$.

2 (a) (i) Find the equation of the plane containing the points $A(2,1,1)$, $B(0,4,1)$ and $C(-2,1,4)$.

(ii) Find the angle between the planes given by
$x - 2y + z = 0$
$2x + 3y - 2z = 0$

(b) (i) Find the shortest distance between the point $Q(1,5,-4)$ and the plane $3x - y + 2z = 6$.

(ii) Find the limit if it exists:
$$\lim_{(x,y)\to(0,0)} \frac{3x^3 - 2x^2 + 3y^2x - 2y^3}{x^2 + y^2}$$

3 (a) (i) For $f(x,y) = xe^{x^2 y}$, find f_x and f_y and evaluate each at the point $(1, \ln 2)$.

(ii) Find the second partial derivatives of $f(x,y) = 3xy^2 - 2y + 5x^2y^2$ and determine the value of $f_{xy}(-1, 2)$.

(b) (i) Find the total differential dz for $z = 2x\sin y - 3x^2y^2$.

(ii) Use the differential to approximate the change in $z = \sqrt{4 - x^2 - y^2}$ as point (x,y) moves from the point $(1,1)$ to $(1.01, 0.97)$.

4 (a) (i) Show that $f_x(0, 0)$ and $f_y(0, 0)$ both exist, but that f is not differentiable at $(0, 0)$ where f is defined as

$$f(x,y) = \begin{cases} \dfrac{-3xy}{x^2 + y^2}, \text{ if } (x,y) \neq (0,0) \\ 0 \text{ if } (x,y) \neq (0,0) \end{cases}$$

(ii) Consider the function $w(x,y,z) = xy + yz + xz$ where $x = s\cos t$, $y = s\sin t$ and $z = t$.

Find $\dfrac{\partial w}{\partial s}$ when $s = 1$ and $t = 2\pi$.

(b) Find the relative extrema of $f_{xy}(x,y) = -x^3 + 4xy - 2y^2 + 1$.

5 (a) (i) Find the particular solution of the equation $xy\,dx + e^{-x^2}(y^2 - 1)\,dy = 0$, $y(0) = 1$.

(ii) Verify that the function $f(x,y) = xe^{x/y} + y\sin(y/x)$ is a homogeneous function and state its degree.

(b) (i) Find the general solution of $(x^2 - y^2)dx + 3xydy = 0$.

(ii) Find the general solution of $xy' - 2y = x^2$.

6 (a) (i) Find the general solution of $y' + xy = xe^{-x^2}y^{-3}$.

(ii) Solve the differential equation $y'' + 6y' + 12y = 0$

(b) Use Taylor series to find the solution of $y' = y^2 - x$, $y(0) = 1$,

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END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2009/2010 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M232: REAL ANALYSIS II

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS : Answer any **Five** (5) questions from this paper
Where necessary show all the essential working
Omission of essential working may result in loss of marks

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1 (a) Define
(i) a convergent sequence of real numbers.
(ii) a bounded sequence of real numbers.

(b) Let (x_n) be a sequence of real numbers which converges to a real number l show that the sequence is bounded.

(c) Find the smallest positive integer N_0 such that $\left|\frac{3n+1}{n+2}-3\right| < \frac{1}{9}$ for all $n > N_0$

2. (a) (i) Define a subsequence of a sequence of real numbers.
(ii) State the Cauchy criterion for convergence.

(b) Let $(x_n)_{n=1}^{\infty}$ be a Cauchy sequence and let $(x_{n_k})_{k=1}^{\infty}$ be its subsequence such that $x_{n_k} \to x$ as $k \to \infty$, show that $x_n \to x$.

(c) Given that $\left(1+\frac{1}{n}\right)^n \to e$ as $n \to \infty$, find $\lim_{n\to\infty}\left(1-\frac{2}{n}\right)^n$

3. (a) Define
(i) a divergent sequence of real numbers.
(ii) limit supremum and limit infimum of the sequence of real numbers

(b) Let $\alpha > 1$ be a real number. Prove that $\frac{\alpha^n}{n^2} \to \infty$ as $n \to \infty$.

(c) Let $x_n = (-1)^n\left(1+\frac{1}{n}\right)$ be the n^{th} term of a sequence $(x_n)_{n=1}^{\infty}$
(i) show that (x_n) is bounded.
(ii) Determine the $\limsup x_n$ and $\liminf x_n$

4. (a) State
   (i) the Sandwich Rule for convergence of sequences.
   (ii) the Nested Interval Theorem for sequences.

   (b) Let $\alpha \geq 1$ be a real number. Prove that $\lim_{n\to\infty} \alpha^{\frac{1}{n}} = 1$.

   (c) Let $I_n = \left(0, \frac{1}{n}\right)$ be a sequence of nested intervals. Show that $\bigcap_{n=1}^{\infty}\left(0, \frac{1}{n}\right) = \phi$.

5. (a) $(x_n)_{n=1}^{\infty}$ is a sequence of real numbers.
   (i) What does the symbol $\sum_{i=1}^{\infty} x_i$ denote?
   (ii) When is $\sum_{i=1}^{\infty} x_i$ said to be convergent?

   (b) Show that the geometric series
   (i) $1+2+2^2+\ldots\ldots\ldots+2^n+\ldots\ldots$, diverges to $+\infty$.
   (ii) $1+\frac{1}{3}+\frac{1}{3^2}+\ldots\ldots+\frac{1}{3^n}+\ldots\ldots$, converges and find its sum.

   (c) Suppose the series $\sum_{n=1}^{\infty} x_n$ in **R** converges to a real number, show that $\lim_{n\to\infty} \sum_{k=n+1}^{\infty} x_k = 0$.

6. (a) State the first principle criterion for series of positive terms.

   (b) (i) If $a \in \mathbf{R}$, $a \geq 1$, prove that $\sum_{n=o}^{\infty} a^n$ is not convergent.
   (ii) If $a \in \mathbf{R}$, $0 < a < 1$, prove that $\sum_{n=o}^{\infty} a^n$ is convergent.

   (c) (i) State and prove Cauchy's root test for series of positive terms.
   (ii) State and prove Cauchy's ratio test for series of positive terms.

7. Given the power series $\sum_{n=o}^{\infty} a_n x^n$ and $\mu = \limsup \sqrt[n]{|a_n|}$, prove the following:

(a) if $\mu = 0$, the power series is convergent everywhere;

(b) if $\mu = +\infty$, the power series is nowhere convergent;

(c) if $0 < \mu < +\infty$ the power series

(i) converges absolutely for every $|x| < \frac{1}{\mu}$;

(ii) diverges for every $|x| > \frac{1}{\mu}$.

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

2009/2010 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M325 – GROUP AND RING THEORY

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

Instructions: i) Answer **three (3)** questions from **Section A** and **one (1)** from **Section B**

ii) **All** questions carry **equal** marks

iii) Show **all essential** working to **earn** full marks

SECTION A (GROUP THEORY)

1. a) Define the following:
   - i) A group
   - ii) A Sylow-p subgroup
   - iii) The center of a group

   b) Prove the following:
   - i) The intersection $H \cap K$ of two subgroups H and K of a group G is also a subgroup of G.
   - ii) The center $Z(G)$ of a group G is a normal subgroup of G.
   - iii) Let H be a Sylow-p subgroup of G. Prove that H is the only Sylow-p subgroup of G contained in $N(H)$.

   c) i) Determine whether the set $\mathbf{Z}_5$ of integers under multiplication modulo 5 forms a group
   - ii) State Sylow's second and third theorems
   - iii) Determine the center of the symmetric group S_3.

2. a) Define the terms
   - i) Permutation group
   - ii) Stabilizer of an element in a set
   - iii) Orbit of an element in a set

   b) i) Show that if a pair of cycles $\alpha = (a_1, a_2, \cdots, a_m)$ and $\beta = (b_1, b_2, \cdots, b_n)$ have no entries in common, then $\alpha\beta = \beta\alpha$.
   - ii) Show that the orbits of the elements of a set S form a partition of S.

iii) Prove that the stabilizer of an element s in a set S is a subgroup of a group G of all permutations of the set S.

c) i) Show that the set S_3 of all permutations of the set $\{1,2,3\}$ forms a group under function composition.

ii) Let
$G = \{(1),(12)(34),(1234)(56),(13)(24),(1432)(56),(56)(13),(14)(23)(24)(56)\}$.
Find the stabilizer and orbit for each of the elements $3,4,5$ and 6.

iii) Let $\alpha = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 4 & 1 & 5 & 2 & 3 & 6 \end{bmatrix}$ and $\beta = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 6 & 4 & 5 & 3 & 1 & 2 \end{bmatrix}$. Determine the orders of $\alpha^3\beta^{-4}$ and $\alpha^{-5}\beta^{-2}$.

3. a) Define the following:
i) A normal subgroup
ii) Conjugate elements in a group
iii) Order of an element in a group

b) Prove the following:
i) If G is a group and $Z(G)$ is the center of G, then G is abelian if $G/Z(G)$ is cyclic.
ii) Conjugacy of elements in a group is an equivalence relation
iii) If G is a group and g is an element of G such that $|g| = n$, then $< g >= \{e, g, g^2, \cdots, g^{n-1}\}$ and $g^i = g^j$ if and only if n divides $i-j$.

c) i) Determine whether $H = \{(1), (12)\}$ is a normal subgroup of S_3
ii) Calculate all the conjugacy classes for the group $\mathbf{Z}_6$ of integers under addition modulo 6.
iii) Determine the order of each of the elements of the symmetric group S_3

4. a) Define the following:
i) An external direct product of groups $G_1, G_2, \cdots, G_n$.
ii) An internal direct product
iii) A group homomorphism

b) Prove the following:
i) The order of an element of a direct product of a finite number of finite groups is the least common multiple of the orders of the components of the element.
ii) Let G be a group, and let $H = \{(g,g) : g \in G\}$. Show that H is a subgroup of $G \oplus G$.
iii) Prove that the kernel $Ker\phi$ of a homomorphism ϕ from a group G to another group $\bar{G}$ is a normal subgroup of G.

c) i) Write down the Cayley table for the group $\mathbf{Z}_2 \oplus \mathbf{Z}_3$.

ii) Find the order of each element in $\mathbf{Z}_3 \oplus \mathbf{Z}_2$.

iii) Let $\mathbf{R} - \{0\}$ be the group of non-zero real numbers under ordinary multiplication. Show that the mapping $\phi : \mathbf{R} - \{0\} \to \mathbf{R} - \{0\}$ defined by $\phi(x) = |x|$ is a homomorphism. Determine the kernel of ϕ.

SECTION B (RING THEORY)

5. a) Define the following

i) An Integral domain

ii) A subring

iii) A unit of a ring

b) Prove the following

i) Every finite integral domain is a field

ii) If S and U are subrings of R, then $S \cap U$ is a subring of R

iii) If n is an integer and r is an element of a ring, then $n(-r) = -(nr)$

c) i) Show that the ring of Gaussian integers $z[i] = \{a + bi : a, b \in \mathbf{Z}\}$ is an integral domain.

ii) Show that $\{0, 2, 4\}$ is a subring of the ring $\mathbf{Z}_6$ of integers under addition and multiplication modulo 6.

iii) Find the set of all units of the ring $\mathbf{Z}_6$ of integers under addition and multiplication modulo 6.

6. a) Define the following terms

i) Ring

ii) Ideal of a ring

iii) Ring homomorphism

b) Prove the following

i) If R is a ring and $a, b, c \in R$, then $a(b - c) = ab - ac$ and $(-a)(-b) = ab$.

ii) The intersection of any two ideals of a ring is an ideal of the ring.

iii) If $\phi : R \to S$ is a ring homomorphism and A is a subring of R, then $\phi(A)$ is a subring of S.

c) i) Show that the set $\mathbf{Z}_3$ of integers under addition and multiplication modulo 3 is a ring.

ii) Let $\phi : R \to S$ be a ring homomorphism. Show that $Ker\phi$ is an ideal of R.

iii) Show that the mapping $\phi : \mathbf{C} \to \mathbf{C}$ defined by $\phi(a + bi) = a - bi$ is a ring isomorphism.

END OF EXAMINATION

THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

Department of Mathematics & Statistics

SECOND SEMESTER FINAL EXAMINATIONS

May, 2010

M412—FUNCTIONS OF A COMPLEX VARIABLE II

Time allowed : THREE(3) HOURS

Instructions : There are six(6) questions. Answer **ANY FIVE (5)** questions. All questions carry equal marks. Show all your working to earn full marks.

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1. (a) State and prove Liouville's theorem.

   (b) Find the Laurent series expansion of

$$f(z) = \frac{1}{z(z^2 - 3z + 2)}$$

   in the annular domain $0 < |z| < 1$.

   (c) (i) State the Mean Value theorem.

   (ii) Hence, considering the function $f(z) = \sin z$ on the unit circle, show that

$$\int_0^{2\pi} \cos(\cos\theta)\sinh(\sin\theta)\mathrm{d}\theta = 0.$$

2. (a) State the Maximum Modulus Principle.

(b) Find the maximum value of $|f(z)| = |\cos z|$ in the rectangular region $0 \leq x, y \leq 2\pi$ when $z = x + iy$.

(c) In each case below write the principal part of the function at its isolated singularity. Then determine if that singularity is a pole, an essential singularity, or a removable singularity.

(i) $f(z) = \frac{1}{z}e^z$.

(ii) $f(z) = \frac{\cos z}{z}$.

3. (a) Without using the Residue theorem, by integrating $f(z) = \frac{ze^{iz}}{z^2+a^2}$ around a suitable contour, prove that

$$\int_0^\infty \frac{x \sin x}{x^2 + a^2} dx = \frac{\pi}{2e^a}, \quad \text{where} \quad a > 0.$$

(b) Let C denote the circle $|z| = 2$ described in the positive sense. Determine the value of $\Delta_c \arg f(z)$ for the function

$$f(z) = \frac{z - (\frac{1}{2} + \frac{i\sqrt{3}}{2})}{z^3(z - 2\pi)^2}.$$

(c) Find the analytic continuation of the function

$$f(z) = \int_0^\infty te^{-zt} dt, \ (Rez > 0)$$

in the domain consisting of all the points in the complex plane except the origin.

4. (a) State and prove the Cauchy Inequality theorem.

(b) Verify the Cauchy Inequality theorem for the function $f(z) = \frac{1}{2z+1}$ if z lies on the circle $|z - 3| = 2$.

(c) Show that the function

$$f_1(z) = \frac{1}{z^2 + 1}, \ (z \neq \pm i)$$

is the analytic continuation of the function

$$f(z) = \sum_{n=0}^{\infty} (-1)^n z^{2n}$$

into the domain consisting of all the points in the complex plane except $z = \pm i$.

5. (a) (i) State Rouche's theorem.

(ii) Using Rouche's theorem, show that the roots of the equation $z^4 + 6z + 1 = 0$ lie within the circle $|z| < 2$ but one root lies inside the circle $|z| < \frac{3}{2}$.

(b) Evaluate

$$\int_C \frac{f'(z)}{f(z)} dz$$

if C is the circle $|z| = 3\pi$ for

$$f(z) = \frac{\sqrt{2}\sin z - 1}{(z-1)^2(z+5)}.$$

(c) (i) Find the Laurent series expansion of $f(z) = \frac{e^{-z}}{(z-2)^4}$ in the domain $0 < |z-2| < R$, for arbitrarily large R.

(ii) Hence find the residue of $f(z)$ at its singularity.

6. (a) State the residue theorem.

(b) Using the residue theorem, evaluate

$$\int_C \frac{1}{z(2z-5)(z-4)} dz,$$

where $C = \{z : |z+2| + |z-2| = 6\}$, positively oriented.

(c) Given the function $f(z) = \frac{1}{z^2(1-z)}$, find the Laurent series expansion in powers of z for $f(z)$ in the region $0 < |z| < 1$.

END.

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

2009 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M422 : MODULE AND FIELD THEORY

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: Answer **Five(5)** Questions in all to include at least two (2) questions from each section.

SECTION A (MODULE THEORY)
(Answer at least two (2) questions from this section)

1. (a) Define each of the following terms:

   (i) the map $\phi : M \to N$ from an R – module M to an R – module N is an R – homomorphism.

   (ii) the kernel (ker ϕ) of the R – homomorphism ϕ.

   (b) Prove that ker ϕ is an R – submodule of M.

   (c) Prove that the quotient module m/ker ϕ is isomorphic to the image *im* ϕ of ϕ.

2. (a) What is the meaning of each of the following terms:

   (i) M is a finitely generated R – module?

   (ii) the order ideal o(m) of an element m of an R – module M.

   (b) Show that if each element m of an R – module M has a unique expression of the form
   $$m = r_1 m_1 + r_2 m_2 + \ldots + r_i m_i ,$$
   then each mi is a torsion element of M.

   (c) For a given R – module M, define a subset T by $T = \{m \in M \mid o(m) = 0\}$, where o(m) denotes the order ideal of M. Then prove that the quotient M / T is a torsion module.

3. (a) Let R be a principal ideal domain. Then give the meaning of each of the following:

(i) the p – component of an R – module M?

(ii) the invariant factors of an R – matrix A?

(b) Let M be a finitely generated R – module over a principal ideal domain R. Then prove that the subset M_p of M defined by
$M_p = \{ m \in M \mid p^k_m = 0 \}$ for some $k \in \mathbb{Z}^+$, some prime element $p \in R$ }
is a sub module of M.

(c) Given that A is a matrix over the ring $\mathbb{Z}$ of integers, find matrices Q and P such that Q A P is an invariant factor were

$$A = \begin{pmatrix} 2 & 4 & 3 \\ 3 & 9 & 6 \\ 4 & 8 & 6 \end{pmatrix}$$

SECTION B (FIELD THEORY)
(Attempt at least two (2) questions from this section)

4. (a) Define each of the following terms:

(i) an algebraic field extension.

(ii) the splitting field for a polynomial $f(x)$ over $k[x]$.

(b) Show that if an extension L : K is finite then the field L is algebraic over K.

(c) Construct the splitting field L for the following polynomials $f(x) \in k[x]$, where

(i) $f(x) = x^4 - 3x^2 + 4$ and k = Q, field of rationals

(ii) $f(x) = x^4 + 3x^2 - 18$ and $k = \mathbb{Z}_7$.

5. (a) What is the meaning of each of the following:

(i) the Galois Group of a field extension L : K?

(ii) intermediate fields of the field extension L : K?

(b) Show that the Galois group of a polynomial $f(x)$ over the field K is a subgroup of the symmetric group S_n of degree n, where n is the degree of the polynomial $f(x)$.

(c) Determine the Galois group of the splitting field L of $f(x)$ over the ground field K, where

(i) $f(x) = x^4 + x^2 - 6 \in Q[x]$

(ii) $f(x) = x^4 + x^2 - 6 \in \mathbb{Z}_7$ [7].

In each case determine all the normal subgroups of the Galois group and also determine all fields $\in$ such that $K \leq \in \leq L$.

6. (a) What is meant by the saying that "a polynomial equation $f(x) = 0$ is solvable by radicals"?

(b) (i) Show that the polynomial $f(x) = x^6 + 3$ is irreducible over the field Q of rationals.

(ii) Show further that if α is a root of $f(x) = x^6 + 3$, then $\frac{1}{2}(1 + \alpha^3)$ is a 6^{th} root of unity. Hence deduce that the roots of $f(x)$ are of the form $\varepsilon^i\alpha$ where $\varepsilon = \frac{1}{2}(1 + \alpha^3)$, $i = 1, 2, \ldots$

(c) Deduce that $Q(\alpha)$ is the splitting field for $x^6 + 3$ over Q and calculate its Galois group. Hence deduce that the Galois of $Q(\alpha) : Q$ is solvable and that $x^6 + 3$ is solvable by radicals.

END OF EXAMINATION.

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

2009 ACADEMIC YEAR
SECOND SEMESTER FINAL EXAMINATIONS

M962 : TIME SERIES ANALYSIS

TIME ALLOWED: Three (3) Hours

INSTRUCTIONS: Answer Any **Five** (**5**) Questions. All Questions Carry Equal Marks.

In the following questions, a_t represents a zero mean white noise process with variance σ_a^2 and B is the back shift operator.

1. (a) The annual profits of Kansanshi Copper Mines since 2005 are

Year	Proft (Billion kwacha)
2005	2.13
2006	18.10
2007	39.80
2008	81.40
2009	112.00

(i) Suggest whether linear or non linear trend equation will be appropriate.

(ii) Determine the trend equation you have suggested in part (i).

(iii) Find the projected profit for 2010.

(b) The quarterly sales of Woolworth store in millions of kwacha from 2008 to 2009 is given in the following table:

Year	Winter	Spring	Summer	Fall
2008	117	80.7	129.6	76.1
2009	118.6	82.5	121.4	77.0

(i) Compute quarterly centered moving averages for Summer and Fall of 2008.

(ii) The mean seasonal indices using the above data are given in the following table:

	Winter	Spring	Summer	Fall
Mean index	119.35	81.66	125.31	74.24

Correct these means and obtain the adjusted seasonal indices.

(iii) Explain the typical index for the Winter season.

2. (a) Define the following:

(i) Stochastic process.

(ii) Time series.

(iii) Weakly Stationary Stochastic process.

(iv) Autocovariance function.

(v) The autocorrelation function of a white noise process.

(vi) The partial autocorrelation function of a white noise process.

(b) The following table represents two hourly readings on the concentration of a chemical process on a certain day in a pharmaceutical company:

Time	Concentration
2 hours	17.0
4 hours	16.6
6 hours	16.3
8 hours	16.1
10 hours	17.3

(i) Obtain the 1 – step ahead forecast for the concentration at 12 hours using simple exponential smoothing with initial value $\hat{x}_1 = x_1$ and smoothing parameter $\alpha = 0.2$.

(ii) Calculate the SSE to three decimal places.

3. (a) The following data represents first ten values of a stationary time series:

5, 1, 4, −4, 3, −3, 7, 0, −1, 8

(i) Find the first three sample autocorrelations $(\hat{\rho}_1, \hat{\rho}_2, \hat{\rho}_3)$.

(ii) Calculate the 95% significance bounds for ρ_1.

(iii) Test at 0.05 level of significance, $H_0: \rho_1 = 0$ against $\rho_1 \neq 0$.

(iv) Test at 0.05 level of significance, $H_0: \rho_2 = 0$ against $\rho_2 \neq 0$.

(v) Test at 0.05 level of significance, $H_0: \rho_1 = \rho_2 = \rho_3 = 0.$, Ha : at least one of the autocorrelations is not zero.

(b) (i) The following data represents the first ten autocorrelations of a time series consisting of 36 observations. Test at 5% level of significance, if the time series comes from a white noise process.
0.103, 0.099, −0.043, −0.031, −0.183, 0.025, 0.275, −0.004, −0.011, −0.152.

(ii) First ten autocorrelations of the monthly index of Lusaka Stock exchange for the period January 2007 to December 2009 were as follows:

Time lag	1	2	3	4	5
Autocorrelation	.889	0.765	.631	.509	.4
Time lag	6	7	8	9	10
Autocorrelation	.313	.238	.188	.149	.108

Discuss the stationarity of the monthly index time series.

4. (a) Determine which of the following stochastic processes $\{Z_t\}$ are second order stationary.

(i) $Z_t = (-1)^t a_t$

(ii) $Z_t = a_1 + a_2 + \ldots + a_t$

(iii) $Z_t = a_t + a_{t-1} + a_{t-2} + a_{t-3}$

(b) (i) Find the autocorrelation function of the process $\{Z_t\}$ where

$$Z_t - \mu = a_t - \theta a_{t-1}, \quad -1 \leq \theta \leq 1$$

(ii) Find an invertible stationary process which has the following autocorrelation function:
$\rho_0 = 1$, $\rho_1 = .25$ and $\rho_k = 0$ for $k \geq 2$.

5. (a) The model $Y_t - 2\cdot3 = \varphi_1(Y_{t-1} - 2\cdot3) + \varphi_2(Y_{t-2} - 2\cdot3) + a_t$ was fitted to the time series of annual tobacco production in Kabwe in tons from 1980 to 2009.

(i) Derive difference equations for ρ_1 and ρ_2.

(ii) Apply method of moments to the difference equation of part (i) to estimate φ_1 and φ_2 using the following sample statistics $\hat{\rho}_1 = \cdot2$, $\hat{\rho}_2 = \cdot5$

(b) Consider the model $(1-B)^2 Z_t = (1 + \cdot25\ B^2)a_t$

(i) Determine if the model for Z_t is stationary.

(ii) Let $Y_t = (1 - B)^2 Z_t$. Determine if the model for Y_t is stationary.

(iii) Show that the model for Y_t is invertible.

(iv) Find the autocorrelation function for the process $\{Y_t\}$.

6. (a) The stationary process $Y_t - 4.77 = 1.54\,(Y_{t-1} - 4.77) - 0.67\,(Y_{t-2} - 4.77) + a_t$ was fitted to the annual time series of the timber production (in millions of board feet) from 1980 to 2009 in Zambia. The last four observations in the time series are $Y_{2009} = 5.30$, $Y_{2008} = 5.53$, $Y_{2007} = 5.77$ and $Y_{2006} = 5.83$. Assume $\sigma_a^2 = 1$.

(i) Forecast Y_{2010}, Y_{2011} and Y_{2012}

(ii) Find 95% forecasts limits for the forecasts in (i). (Do not simplify).

(iii) Update your forecasts when the 2010 observation became available and equaled 4.97. You may use the following updated forecast equation: $Z_{n+1}(\hat{\ell}) = Z_n(\hat{\ell}+1) + \psi_\ell(Z_{n+1} - Z_n(\hat{1}))$

(b) (i) The following data represents observations on a stationary time series X_t.

20.3, 21.4, 20.8, 19.3, 20.1, 21.3, 20.6

Compute 1 – step ahead forecasts $\hat{x}_1$, $\hat{x}_2$, ..., $\hat{x}_7$ and corresponding 1 – step ahead forecast errors e_1, e_2, ... e_7 based on the model $X_t = \cdot6\,X_{t-1} + a_t$ and setting $\hat{x}_1 = 20\cdot3$.

(ii) Describe briefly how a fitted model is validated.

END OF EXAMINATION.

The University of Zambia
Physics Department
University Examinations 2010
P-192: Introductory Physics- II
(Option A)

All questions carry equal marks. The marks are shown in brackets. Question 1 is compulsory. Attempt four more questions. Clearly indicate on the answer script cover page which questions you have attempted.

Time: Three hours. **Maximum marks = 100.**

Do not forget to write your computer number clearly on the answer book as well as on the answer sheet for Question 1. Tie them together!!

==========

Wherever necessary use:

$g = 9.8 m/s^2$

1 metric ton = 1000 kg

$P_A = 1.01 \times 10^5$ N/m^2

1 cal. = 4.18 J

$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2

$c = 3 \times 10^8$ m/s

$h = 6.63 \times 10^{-34}$ J-s

1 pascal =1 N/m^2

1eV = 1.6×10^{-19} J

$e = 1.6 \times 10^{-19}$ C

$m_e = 9.11 \times 10^{-31}$ kg

$k = 9 \times 10^9$ Nm^2/C^2

$\mu_0 = 4\pi \times 10^{-7}$ N/A^2

$\rho_{water} = 1000$ kg/m^3

$G = 6.67 \times 10^{-11}$ Nm^2/kg^2

Efficiency of a Carnot engine, $e = 1 - T_2/T_1 = \frac{\textit{work done}}{\textit{input heat at high temperature}}$

Question 1: Sample answers: F (a), G (d).... etc. **DO NOT guess** the answer. For each correct answer, 2 marks. For each wrong answer, 0.67 will be deducted. No answer, zero mark. The minimum total mark for Question 1 is zero. [10 × 2 = 20]

(A) To a stationary observer the frequency of a sound source moving towards the observer appears to be:

a) Lower than actual frequency
b) Same as actual frequency
c) Higher than actual frequency
d) Lower or higher than the actual frequency depending on the speed of the source

(B) When air in a parallel capacitor is replaced by a medium of dielectric constant κ, the capacitance:

(a) Decreases κ times
(b) Increases κ times
(c) Remains constant
(d) Increases 1.2 κ times

(C) Two identical heaters, each marked 1000 W, 250 V are placed in parallel with each other and are connected to a 250 V supply. Their combined heating will be:

(a) 1000 W
(b) 500 W
(c) 1250 W
(d) 2000 W

(D) A positively charged glass rod attracts a small object. The object must be:

(a) Negatively charged
(b) Neutral
(c) Either negatively charged or neutral
(d) A magnet

(E) A proton has a mass of 1840 times that of an electron. If a proton is accelerated from rest through a potential of 1 volt, its kinetic energy is:

(a) 1840 eV
(b) 1 eV
(c) 1.6×10^{-19} eV
(d) 1 MeV

(F) Which of the following produces more severe burns:

(a) Boiling water
(b) Hot air
(c) Steam
(d) Boiling porridge

(G) Two wires *A* and *B* are made of the same metal are both 1 meter long. Wire *A* is 1 mm thick wire *B* is 2 mm thick. The resistance of wire *A* is

(a) 2 times more than *B*
(b) Half that of *B*
(c) The same for both
(d) More information is needed to compare them

(H) The velocity of sound is largest in:

(a) Vacuum
(b) Water
(c) Air
(d) Steel

(I) When the distance between two charged particles is halved, the coulomb force is:

(a) One-half
(b) One-fourth
(c) Four times
(d) Double

(J) If the electric field intensity **E** is uniform, then the electric field lines of force are:

(a) Convergent
(b) Divergent
(c) Circular
(d) Parallel

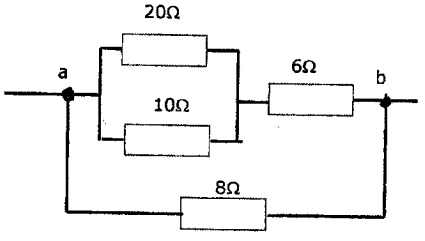
ATTEMPT ANY FOUR QUESTIONS FROM BELOW:

Q.2 (a) Two spheres are both positively charged with a combined charge totaling 4×10^{-8} C. Calculate the charge on each sphere if they are repelled with a force of 27×10^{-5} N when they are 0.1 m apart. **[10]**

(b) The sound source of a ship's sonar system operates at a frequency of 50 kHz. The velocity of sound in water is 1450 ms^{-1}. Calculate:

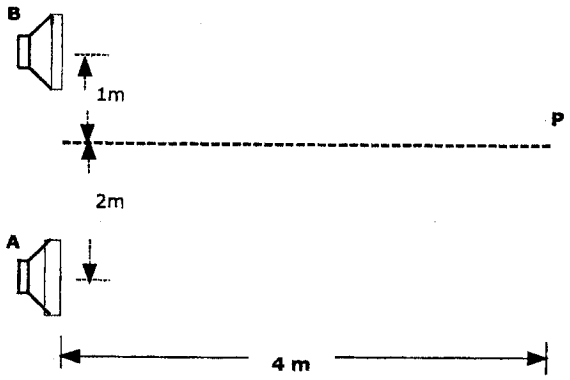
i) the wavelength of the waves emitted by the source;
ii) the difference in frequency between the directly radiated waves and the waves reflected from a whale traveling directly away from the ship at a speed of 6.95 ms^{-1}. **[6]**

(c) Find the equivalent resistance between points *a* and *b* in the figure below. **[4]**

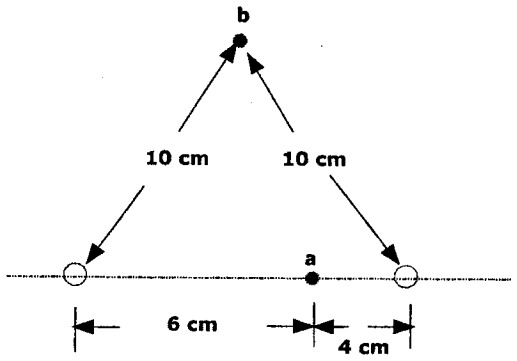


Q.3 (a) Two small loudspeakers *A* and *B* are positioned as shown below, are driven by the same amplifier and emit pure sinusoidal waves in phase. If the speed of sound in air is 350 m/s. Find:

i) the frequencies at which constructive interference occurs at point *P*,
ii) the frequencies at which destructive interference occurs at point *P*. **[11]**



(b) Two point charges q_1 = +12 x 10^{-9} C and -12 x 10^{-9} are placed 10 cm apart as shown in the figure below. Calculate the potentials at points *a* and *b*. **[6]**

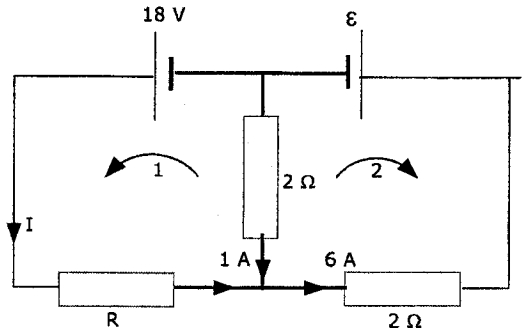


(c) State Hooke's law and explain the significance of the minus in the equation. **[3]**

Q.4 (a) Two trains travelling at 72 km/h and 180 km/h are crossing each other while the second train is whistling. If the frequency of the whistle is 800 Hz, find the apparent frequency of the whistle as heard by the driver of the first train:

i) before the trains cross each other; and
ii) after they cross each other. (velocity of sound = 350 m/s) **[8]**

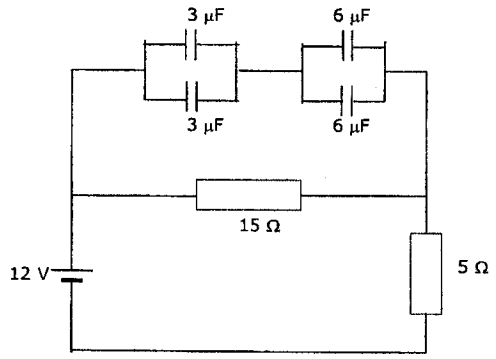
(b) In the figure below, find the unknown current I, resistance R and the emf ε. Use the indicated directions to form your loops. **[7]**



(c) A 1 kW refrigerator whose coefficient of performance is 2.0 takes heat from a freezer compartment at -20 °C and exhausts it at 40 °C.

i) How does its COP compare with that of an ideal refrigerator?
ii) At what rate does the refrigerator remove heat from the freezer compartment? **[5]**

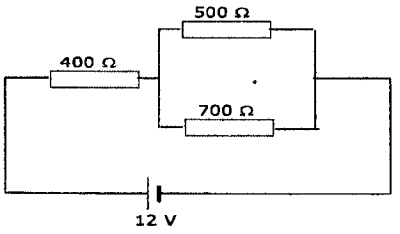
Q.5 (a) The figure below shows a circuit containing a 12 V battery, two resistors, and four capacitors. What is the potential difference between the plates of the 3 μF and 6 μF capacitors?



(b) Let I_o represent the average intensity level of sound produced by 10 people conversing with each other in a room. Approximately how many people engaged in conservation in the same room would cause the average intensity level in decibels to treble? **[9]**

Q.6 (a) A spring of length 50 cm has a spring constant of 2000 N/m. When a mass of 12 kg is suspended from it, what will be the stretched length of the spring? If the mass is pulled down and released, what will be the period of oscillation? **[6]**

(b) In the circuit shown in the figure below, how much current is drawn from the battery? Also find the currents through the 500 Ω and 700 Ω resistors. **[7]**



(c) 200 cm^3 of tea at 95 °C is poured into a 150 g glass cup initially at 25 °C. What will be the final temperature T of the tea when equilibrium is reached, assuming no heat flows to the surroundings and taking tea as being essentially water? (c_{cup} = 840 J/kg. °C, c_{water} = 4184 J/kg. °C) **[5]**

(d) Is Ohm's law valid for all conductors? Explain your answer. **[2]**

Q.7 (a) The efficiency of a Carnot engine is 0.45. When the temperature of the cold reservoir is lowered by 50 °C the efficiency becomes 0.55. Find the temperatures of the hot and cold reservoirs. **[10]**

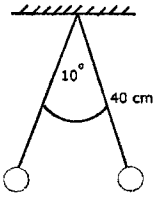
(b) A parallel plate capacitor has an area of 2 cm^3 and a plate separation of 1.5 mm.

i) Find its capacitance,
ii) How much charge is on the positive plate if the capacitor is connected to a 6 V battery?
iii) Calculate the charge density on the positive plate, assuming the density is uniform.
iv) The magnitude of the electric field between the plates. **[6]**

(c) An electric motor draws a current of 20 A from a 240 power source 15 m away. What is the minimum cross-sectional area of the wire that can be used if the voltage at the motor is not to be lower 230 V? ($\sigma_{wire} = 1.7 \times 10^{-8}$) **[4]**

Q.8 (a) Two small metallic spheres each with a mass of 0.1 g are suspended from the same point by two light strings as shown below. The spheres are charged to the same level with charge of the same sign. They come to equilibrium with the strings having an angle of 10° between them. If the strings are 40 cm long, what is the magnitude of the charge on each sphere?

[14]



(b) An air bubble 0.5 cm^3 is formed at the bottom of a lake 30 m deep at a temperature 13 °C. To what volume does it grow when it rises to surface where the temperature is 25 °C and the pressure is one atmosphere? **[6]**

END OF EXAMINATION

Some equations you may find useful:

$\Delta Q = mc\Delta T = nC\Delta T$: $\Delta L = \alpha L \Delta T$: $\Delta V = \gamma V \Delta T$: $\Delta W = P.\Delta V$: $C_v = C_p - R$

$P_1V_1^{\gamma} = P_2V_2^{\gamma}$: $Q = \Delta U + W$: $\Delta W = nRT.ln(V_f/V_i)$: $PV = nRT$: $W = n(C_p-R)$

$P_1V_1^{\gamma}/T_1 = P_2V_2^{\gamma}/T_2$: $W = n(C_p-R)$: $W = nR\Delta T$: $Q/\Delta t = (kA\Delta T)/\Delta L$: $W = nR\Delta T$

$f = (1/2\pi)\sqrt{(k/m)}$: $v = \pm \sqrt{[(k/m)(x_0^2 - x^2)]}$: $f = (1/2\pi)\sqrt{(k/m)}$: $a_{max} = kx_0/m$

$a_c = \omega^2 x_0$: $P.E. = (1/2)kx^2$: $(1/2)kx^2 + (1/2)mv^2 = (1/2)kx_0^2$: $a = -kx/m$

$a_c = \omega^2 x_0$: $P.E. = (1/2)kx^2$: $(1/2)kx^2 + (1/2)mv^2 = (1/2)kx_0^2$: $\omega = \sqrt{(k/m}$: $\omega = 2\pi f$

$v = \sqrt{(B/\rho)}$: $f = (1/2\pi)\sqrt{(g/L)}$: $v = \sqrt{(\gamma RT/M)}$: $v = \sqrt{(Y/\rho)}$: $v = \sqrt{(T/(m/L))}$: : $F = -kx$

$Y = (F/A)/(\Delta L/L_0)$: $B = -\Delta P/(\Delta V/V_0)$: $f = 1/\tau$:

$f / f' = [1 - (v_l/v_w)] / [1 - (v_s/v_w)]$: $f' = f(v/(v \pm v_s)$: $f' = f(v \pm v_l)/(v)$

$F = (k q_1 q_2)/r^2$: $\mathbf{F = qE}$: $qV = (1/2)mv^2$: $W = qV_{AB}$: $v = f\lambda$

$I_o = 10^{-12}\ W/m^2$: $I(dB) = 10\ log(I/I_o)$: $L = 1/2\lambda$: $\lambda = v/f$: $f_1 = v/2L$

$V_{AB} = Ed$: $C = (\varepsilon_o A)/d$: $\Delta R = R_o\alpha\Delta T$: $q = CV$: $E = \sigma/\varepsilon_o$

$x = x_0\ cos(\omega t)$: $\rho = (RA)/L$: $E = (1/2)qV$: $P = IV = I^2R$: $V = IR$: $E = kq/r^2$: $V = kq/r$

: 1 rev = $360^0 = 2\pi$ rads

$Q/\Delta t = Ae\sigma T^4$: $C_v = 3/2R(mono) = 5/2R(diatomic)$: $C_p = 5/2R(mono) = 7/2R(diatomic)$

$C_p/R(N_2) = 3.48$: $C_v/R(N_2) = 2.48$: $M(N_2) = 28$:

volume of a sphere = $(4/3)\pi r^3$: area of a right cylinder = $2\pi rL$

area of a sphere = $4\pi r^2$:

THE UNIVERSITY OF ZAMBIA
School of Natural Sciences
PHYSICS DEPARTMENT

University Examinations: April, 2010
P198: *Introductory Physics* II

(OPTION B)

Instructions: In addition to **Q_1** which is compulsory and for which you use the answer sheet provided, answer **four (4)** more questions. They are of equal marks. All necessary calculations must be clearly shown. Clearly indicate on the answer script cover page which questions you have attempted.

Time: 3 hours **Maximum marks: 100**

Do not forget to write your computer number, clearly on the answer book.

Formulas, data you might find useful:

$$\Delta Q = mc\Delta T;\ \Delta Q = mL_f;\Delta Q = mL_v;\ \frac{\Delta Q}{\Delta t} = \frac{kA\Delta T}{\Delta x};\ \Delta L = \alpha L_o \Delta T;\ PV = nRT$$

$$T_1V_1^{\gamma} = T_1V_2^{\gamma};\quad \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2};\quad PV^{\gamma} = \text{ constant},\quad \Delta Q = \Delta U + P\Delta V.\quad \Delta S = \frac{\Delta Q}{T}$$

$$e = 1 - \frac{Q_L}{Q_H};\quad e = 1 - \frac{T_L}{T_H};\quad E = \varepsilon\sigma T^4;\quad COP = \frac{Q_L}{Q_H - Q_L} = \frac{T_L}{T_H - T_L};\qquad \Delta W = P\Delta V;$$

$$c_v/R(N_2) = 3.48;\quad I = \frac{2}{5}mr^2$$

$$C_v = \frac{3}{2}R\ \text{(mono)} = \frac{5}{2}R\,\text{(diatomic)};\ c_p = \frac{5}{2}R\,\text{(mono)} = \frac{7}{2}R\,\text{(diatomic)}$$

$$\Delta W = nRT\ln\left(\frac{V_f}{Vi}\right);\ P_1V_1^{\gamma} = P_2V_2^{\gamma};\ K.E_{\text{av.}} = \frac{3}{2}kT;\ \Delta Q = nC\Delta T$$

$V = V_o(1+\gamma\Delta T)$; $F = kx$. $P_A = 1\times10^5 \text{Nm}^{-2}$. $T = 4\pi^2\frac{l}{g}$; $\omega = 2\pi f$; $a = -\omega^2 x$; $F = kx$;

$\omega = \sqrt{\frac{k}{m}}$; $k = \frac{2\pi}{\lambda}$; $v = \omega\sqrt{(x_o^2 - x^2)}$; $P_a + \frac{1}{2}\rho v^2 + \rho g h_1 == P_b + \frac{1}{2}\rho v_2^2 + \rho g h_2$;

$A_1 v_1 = A_2 v_2$; $F_D = 6\pi\eta r v_t$; $\gamma = 3\alpha$; $E = k\frac{Q}{r^2}$; $V = \frac{kQ}{r}$; $E = -\frac{\Delta V}{\Delta x}$; $Q = CV$

$E = \frac{1}{2}QV$; $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + ... + \frac{1}{C}$; $C_{eq} = C_1 + C_2 + C_3 + ... + C_n$

$\sum I = 0.$; $\sum V = 0$; $e = -\frac{\Delta\phi}{\Delta t}$; $P = IV$; $F = qE$; $C = \frac{\varepsilon_o A}{d}$

$F = BIL$; $E = \frac{1}{2}qV$; $P = IV = I^2R$; $F = qvB$; $F_c = \frac{mv^2}{r}$; $v = \omega r$

$\frac{f}{f'} = \left[1 - \left(\frac{v_1}{v_w}\right)\right] / \left[1 - \left(\frac{v_s}{v_w}\right)\right]$; $I(\text{dB}) = 10\log_{10}(I/I_o)$;

$R_{eq} = \sum R_i$; $\frac{1}{R_{eq}} = \sum\frac{1}{R_i}$; $R = \rho\frac{L}{A}$

1 rev = 360° = 2π rads

Volume of sphere $V = \frac{4}{3}\pi r^3$

Area of sphere = $4\pi r^2$; $I = \frac{2}{5}mr^2$

Electronic charge, $e = 1.6\times10^{-19}$C.

$P_A = 1.01\times10^5$ Pa

$\rho_w = 1000\ \text{kgm}^{-3}$

1 calorie = 4.184 J

Acceleration due to gravity $g = 9.81\ \text{ms}^{-2}$.

Specific latent heat of fusion for ice, $L_f = 335\times10^3$ J/kg

Specific latent heat of vaporization for steam, $L_v = 2.26\times10^6$ J/kg

Specific heat capacity of water, $c_w = 4.2\times10^3 \text{J kg}^{-1}\text{K}^{-1}$.

Avogadro's number $N_A = 6.0\times10^{23}$ atoms mol^{-1}

Q1: (A) Calorimetry concerns itself primarily with the

(a) Measurement of quantity of heat
(b) Physical effects of temperature change
(c) Conversion of heat to other energy forms
(d) Conversion of heat to internal energy and mechanical work.

(B) The specific heat capacity of a substance is

(a) The mass of the substance which undergoes a unit temperature change per unit mass of substance;
(b) The rate of change of temperature of the substance
(c) The ratio of the heat supplied to the resultant temperature rise per unit mass of substance
(d) The temperature change per unit mass of the substance per unit heat input.

(C) An ideal black body is

(a) A body of unit emissivity
(b) A perfect absorber
(c) A perfect radiator
(d) All of the above

(D) The throttling process is of great importance in

(a) Refrigeration
(b) Attaining high fluid velocities
(c) Controlling the flow velocity of fluids
(d) Extracting heat from gases

(E) A transverse wave of wavelength 2 cm is travelling down a string. If the wave-amplitude is 3cm and a certain point on the string has that displacement at a given instant, the displacement of a point 0.25cm further down the string at the same instant is

(a) 3 cm
(b) 1 cm
(c) 2 cm
(d) 0.25cm

(F) Consider a sound wave of wave-length λ travelling down a tube open at both ends. The fundamental mode of vibration of the air column in the tube is excited if the length, l of the tube is

(a) $l = \lambda$
(b) $l = 2\lambda$
(c) $l = \frac{\lambda}{2}$
(d) $l = 4\lambda$

(G) Calculation of the velocity of efflux from an orifice in a container below the surface of the liquid is based on

(a) Torricelli's theorem
(b) Pascal's law
(c) Bernoulli's principle
(d) Stoke's law

(H) The force per unit charge is known as

(a) Electric flux
(b) Electric potential
(c) Electric field intensity
(d) Coulomb force.

(I) Kirchhoff's rules in electric circuit network analysis are derived from

(a) the work-energy theorem
(b) the conservation of momentum
(c) the conservation of energy
(d) the conservation of energy and electric charge laws.

(J) In figure 1, the direction of the net electric field at point P is

(a) To the left
(b) To the right
(c) Vertically downwards
(d) Vertically upwards.

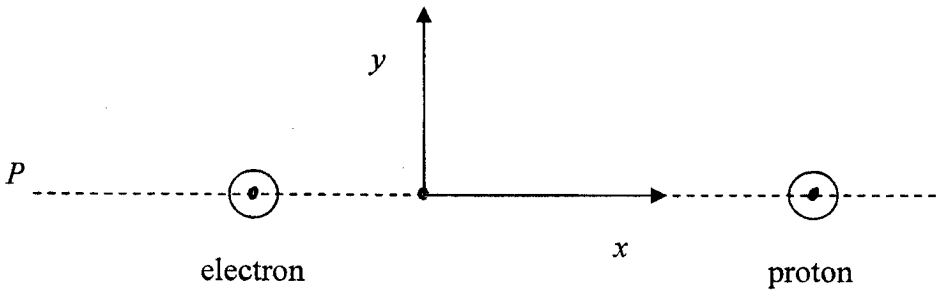


Figure 1

Q2: (a) Water is flowing with a speed of $5.0 ms^{-1}$ through a pipe of cross-sectional area $4\times10^{-6}m^2$. The water gradually descends 10m as the pipe increases in area to $8\times10^{-6}m^2$.

(i) What is the speed of flow at the lower end? [3]

(ii) If the pressure at the upper level is 1.5×10^5Pa, what is the pressure at the lower level? [7]

(b) (i) Show that a standing wave formed from the reflection of a wave of the form $y = 10\sin(kx - \omega t)$ where y is the displacement and $\lambda = 10$ cm is given by

$$y' = 20\sin(2\pi\frac{x}{10})\cos(\omega t) \qquad [6]$$

(ii) Given that the frequency of the wave is 400 Hz, what is the maximum speed of a point on the cord cited in (i)? [3]

(iii) What is the velocity of the wave? [1]

Q3 (a) (i) A copper wire and an iron wire of the same length have the same potential difference applied to them. What must be the ratio of their radii if the current is to be the same? [6]

$\rho_{copper} = 1.7\times10^{-8}\Omega$-m, $\rho_{iron} = 1.0\times10^{-7}\Omega$-m

(ii) A small but measurable current of 1.0×10^{-10}amp is passing in a copper wire whose diameter is 0.25cm. Calculate the electron drift speed, v_d.
(Density of copper $=9.0 gcm^{-3}$)
(Molar mass copper $= 64 gmol^{-1}$)
Note: copper has one free electron per atom. [6]

(b) Calculate the current through the 10Ω, 20Ω, and the 40Ω resistances in figure 2. Hint: it would be helpful to re-draw the circuit. [8]

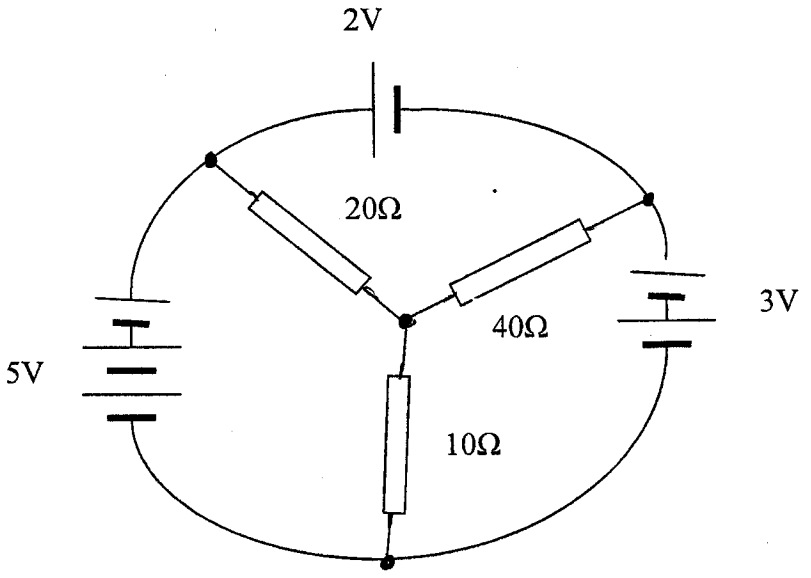


Figure 2

Q4 (a) Explain what is meant by the following:

(i) Iso-volumetric and isothermal processes [2]

(ii) adiabatic process [2]

(iii) isobaric and cyclic processes [2]

(b) A lead bullet shot with a velocity of 630 ms^{-1} strikes a target and stops dead. Calculate the rise in the temperature of the bullet assuming that 25% of the heat produced is used in heating the bullet [5]

(Specific heat capacity of lead 125.52 Kcal g^{-1} $^{o}C^{-1}$)

(c) A gasoline internal combustion engine can be approximated by the cycle shown in figure 3. Assume an ideal gas and use a compression ratio of 4:1. Take $p_2 = 3p_1$ and $V_4 = 4V_1$. Determine, in terms of p_1, T_1 and the ratio of the specific heats of the gas γ, the pressure and temperature of the gas at the following vertex points:

(i) 2, and

(ii) 3,

[9]

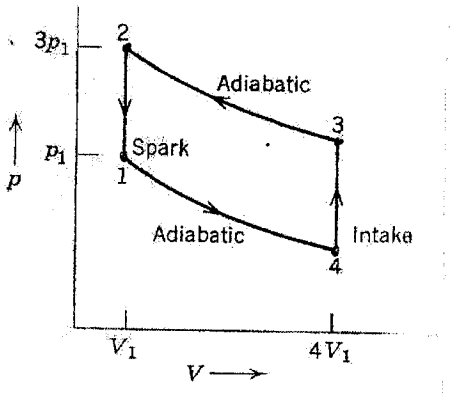


Figure 3

Q5 (a) A parallel plate capacitor in air has a plate separation of 1.50 cm and a plate area of 25.0 cm^2. The plates are charged to a potential difference of 250 V and then disconnected from the source. The capacitor is then placed in distilled water. Determine

(i) the charge on the plates before and after immersion

(ii) the capacitance and potential difference after immersion and

(iii) the change in energy stored in the capacitor.

Assume the liquid to a perfect insulator.

Take $\varepsilon_o = 8.85\times10^{-12}$ farad per meter; $K_{water} = 80$ [10]

(b) A proton moves at 4.50×10^5 ms^{-1} parallel to the $+x$ axis. It then enters a uniform electric field of magnitude 9.60×10^3 NC^{-1} directed vertically upwards. Ignoring gravitational effects, find

(i) the time interval required for the proton to travel 5.00 cm horizontally;

[2]

(ii) its vertical displacement during the time calculated in (i)

[4]

(iii) the horizontal and vertical components of its velocity after it has travelled the 5.00 cm horizontal distance. Mass of proton $m_p = 1.67\times10^{-27}$ kg.

[4]

Q6 (a) A charge Q is uniformly distributed throughout the volume of a **non-conducting** sphere of radius R_o. Using Gauss's law, find the expression for the electric field as a function of distance from the centre of the sphere to infinity and make a **graphical sketch** for these fields. Hint: Find the volume charge density first. [10]

(b) (i) In electrostatics, electric field lines are always oriented at 90° to the surface of a charged object while electric equi-potential lines are parallel to the surface of the same object. State reasons for this. [3]

(ii) You wish to charge a conducting body positive by electrostatic induction. Describe the steps you would take to do this. Note, diagrams would be very helpful. [4]

(c) A coil develops 800 calories per second when 20V is supplied across its ends. Compute its resistance [3]

Q7: (a) A mass moving along the x-axis performe simple harmonic motion of amplitude 10cm and frequency 10Hz as shown in figure 4. At $t = 0$, the mass is located at the amplitude point (point A).

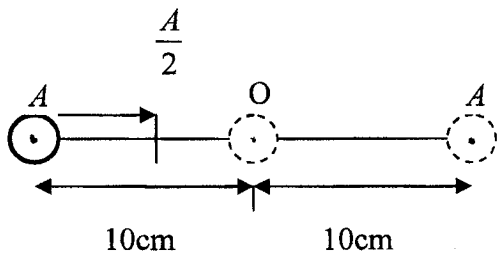


Figure 4

(i) Write the equation of its motion in centimetres. [2]

(ii) Calculate the time required for the mass to move from its position at $t = 0$ to the point middle-way (i.e. $\left(\frac{A}{2}\right)$) between the amplitude and the equilibrium point. [6]

(iii) Calculate the time it will take for the mass to move from the point $\left(\frac{A}{2}\right)$ to the equilibrium position, O. [2]

(b) A solid sphere of mass m and radius b_o is spinning freely on its axis with angular velocity ω_o. When heated by an amount ΔT, its angular velocity changes to ω. Find the ratio $\frac{\omega}{\omega_o}$ if the linear expansion coefficient for the material of which the sphere is made is α. [7]

(c) What temperature gradient must exist in an aluminium rod for it to transmit 8.0 cal per second per cm^2 of cross-sectional area down the rod? $k_T = 210\ WK^{-1}m^{-1}$ for aluminium. [3]

Q8 (a) (i) State Ampere's law. [1]

(ii) Use Ampere's law to show that the magnetic field B created by a long current carrying wire at a point P from the wire is given by $B = \frac{\mu_o I}{2\pi r}$, where I is the current in the wire, r the distance of P from the wire and μ_o is the permeability of free space, figure 5. [3]

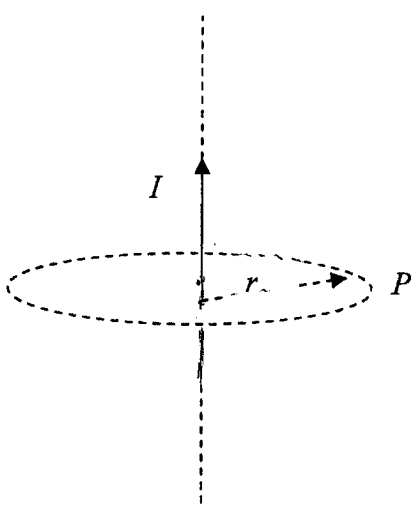


Figure 5

(b) A point charge $+Q$ is at $x = 0$ and another charge $+9Q$ is at $x = 4$ m. Where should a third charge q be placed such that the net force on each of the three charges is zero? Find the **magnitude** and **polarity** of q in terms of Q.

[6]

(c) A rectangular coil of mass 10g that is free to move measures 4 cm × 20 cm. It is placed in the vicinity of a long fixed wire carrying a 3A current as shown in figure 6. If the coil has a current of 2A circulating in it in an anti-clockwise direction, calculate the the **acceleration** and **direction** of motion of the coil in the position shown. [6]

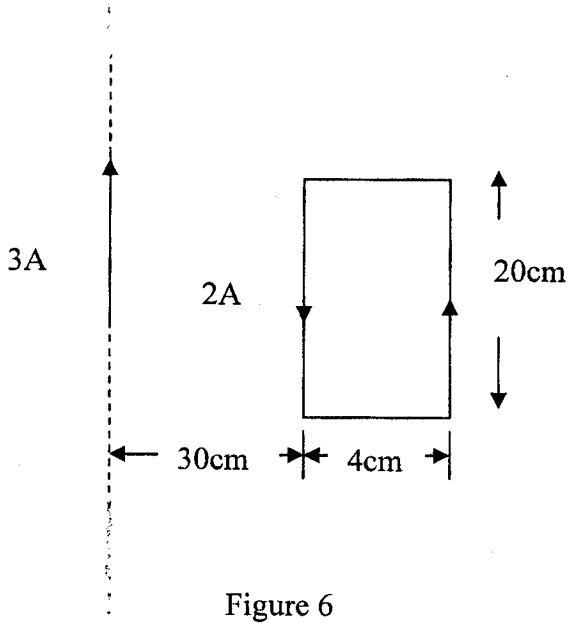


Figure 6

END OF EXAMINATION

UNIVERSITY OF ZAMBIA
PHYSICS DEPARTMENT
UNIVERSITY EXAMINATIONS
SECOND SEMESTER 2010
P252
INTRODUCTION TO CLASSICAL MECHANICS II

TIME: THREE HOURS
ANSWER ANY FIVE QUESTIONS FROM THE SEVEN GIVEN
ALL QUESTIONS CARRY EQUAL MARKS
TOTAL MARKS: 100

Useful formulas

$$k = \left| \frac{d^2V}{dx^2} \right|_{x=x_0}$$

$$p_k = \frac{\partial L}{\partial \dot{q}_k} = \frac{\partial H}{\partial \dot{q}_k}$$

$$\dot{p}_k = -\frac{\partial H}{\partial q_k}, \quad \dot{q}_k = \frac{\partial H}{\partial p_k}$$

$$\frac{d}{dt}\frac{\partial L}{\dot{q}_k} - \frac{\partial L}{\partial q_k} = 0, \; Q_k = \sum_i F_i \frac{\partial x_i}{\partial q_k}$$

$$x' = \gamma(x - Vt), \quad t' = \gamma(t - Vx/c^2), \quad \gamma = \frac{1}{\sqrt{1 - V^2/c^2}}$$

$$v_x' = \frac{v_x - V}{1 - v_x V/c^2}, \quad c = 3 \times 10^8 \text{ m/s}$$

Question 1. (a) A harmonic oscillator of mass m and force constant k vibrates in a resistive medium which offers a resistance cv, where c is a positive constant and v is the velocity. Hence its equation of motion is

$$m\ddot{x} + kx + c\dot{x} = 0.$$

Show that if the oscillator is weakly damped, its position as a function of time is

$$x = x_0 e^{-bt/2}\cos(\omega' t + \delta)$$

where $\omega' = \sqrt{k/m - b^2/4}$ and $b = c/m$. [8 marks]

(b) A particle of mass m moving along the positive x axis is acted upon by a force whose potential is

$$V(x) = \frac{c_1}{x^4} - \frac{c_2}{x^2}$$

where c_1 and c_2 are positive constants. Show that the period of small oscillations about the position of stable equilibrium is

$$T = 2\pi\frac{c_1}{c_2}\sqrt{\frac{m}{c_2}}$$ [12 marks]

Question 2. (a) Derive the wave equation

$$\frac{\partial^2 y(x,t)}{\partial t^2} = v^2\frac{\partial^2 y(x,t)}{\partial x^2}$$

for transverse waves of small amplitude on a string under tension. [10 marks]

(b) (i) Prove that the functions

$$y_\pm = A\sin k(x \pm vt)$$

are solutions of the wave equation. [4 marks]

(ii) Prove that a string clamped at both ends can only vibrate at the frequencies

$$f_n = \frac{nv}{2L}$$ [3 marks]

(iii) Hence find the allowed frequencies of a string of mass 15 g, length 80 cm and under a tension of 600 N. [3 marks]

Question 3. A body is made by welding together a rectangle (sides $a = 30$ cm and $b = 50$ cm, mass $M = 2$ kg) and a disk (radius $R = 10$ cm, mass $m = 1$ kg) so that they are concentric and form a composite body. The horizontal rotational axis of the system is perpendicular to the plane of the body and passes through the centre. A string is wound around the disk and a mass $m' = 0.5$ kg attached is to the free end of the string. The system, illustrated in Figure 1, is released from rest.

(i) Show by means of the basic equation

$$I = \int r^2 dm$$

that the moment of inertia of the body about the rotational axis is given by

$$I = \frac{M}{12}[a+b] + \frac{m}{2}R^2 \quad [14 \text{ marks}]$$

(ii) Show that the acceleration of the system is

$$a = \frac{m'}{m' + I/R^2}g$$

[4 marks]

(iii) Obtain the distance the hanging body falls in the first 5 seconds. [2 marks]

Question 4. **(a)** **(i)** Derive the equation

$$E = mc^2 \quad [12 \text{ marks}]$$

(b) A square uniform lamina lies symmetrically in the xy plane so that its vertices are at $(-a,-a)$, $(-a,a)$, (a,a) and $(a,-a)$. Its mass is initially M. If the part of the square in the first quadrant is removed from the square, what is the centre of mass of the remaining "L" shape? [8 marks]

Question 5. **(a)** **(i)** Explain the major advantage and the major disadvantage of the Hamiltonian formulation of mechanics over the Lagrangian. [2 marks]

(ii) Explain two major advantages of the Lagrangian formulation of mechanics over the Newtonian. [2 marks]

(iv) Explain what is meant by an ignorable coordinate. [2 marks]

(b) A particle of mass m moves under the action of the central force

$$F(r) = -\frac{k}{r^4}$$

The particle moves in a plane and can be described by the generalized coordinates $q_1 = r$ and $q_2 = \theta$.

(i) Obtain the equations of motion of the particle using Hamilton's equations. Interpret the equations. [11 marks]

(ii) Identify any ignorable coordinates and justify the conservation of the corresponding momentum. [3 marks]

Question 6. **(a)** In Cartesian coordinates x and y the force acting on a particle is given by $\mathbf{F} = -\hat{\mathbf{i}}kx - \hat{\mathbf{j}}ky$, where k is a constant. Suppose the system containing the force is treated using the generalized coordinates r and θ such that $x = r\cos\theta$ and $y = r\sin\theta$. Obtain the generalized coordinates Q_r and Q_θ associated with these coordinates and interpret your results. [4 marks]

(b) A system consists of a mass M on a frictionless table top and connected to a vertical spring of force constant k with the aid of a light inextensible string that passes over a frictionless pulley of moment of inertia I. The other end of the spring bears a mass m. The system is illustrated in Figure 2.

(i) Show that if the length of the string is l, the natural length of the spring is y_0 and the radius of the pulley is R, then the Lagrangian of the system is

$$L = \frac{1}{2}M\dot{x}^2 + \frac{1}{2}m(\dot{y}^2 + \dot{x}^2) - m\dot{x}\dot{y} + \frac{1}{2}\frac{I}{R^2}\dot{x}^2 + mg[l + y_0 + y - x] - \frac{1}{2}ky^2$$

where x is the distance of the mass on the table top from the pulley and y is the extension of the spring, while potential energies are measured from the top of the pulley. 6 marks]

(ii) Hence obtain the equations of motion of the system [6 marks]

(iii) Show that the basic relation

$$H = \sum_i p_i \dot{q}_i - L$$

gives the total energy of the system. [4 marks]

Question 7 (a) (i) State the two postulates on which the theory of relativity is founded. [2 marks]

(b) Two inertial frames S and S' are in standard configuration such that S' is moving with relative velocity $V = 0.8c$. A wooden rectangular box measuring 10 m on each edge of rest mass 1 kg is moving with velocity $v' = 0.6c$ parallel to the x' axis in frame S' such that its edges are parallel to the x', y' and z' axes. Relative to the stationary frame S, what is

(i) the velocity of the box? 4 marks]

(ii) the total energy of the box? [3 marks]

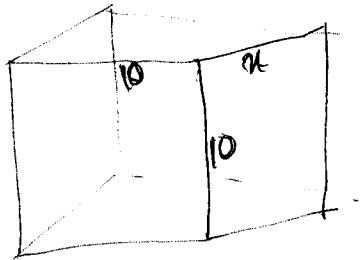
(iii) the volume of the box. [3 marks]

(c) Two neutrons A and B approach each other along a common straight line. Each neutron has a constant speed βc as measured in the laboratory frame, where c is the speed of light. Show that the total energy of neutron B as observed in the rest frame of neutron A is

$$E = \frac{1+\beta^2}{1-\beta^2}m_0c^2$$

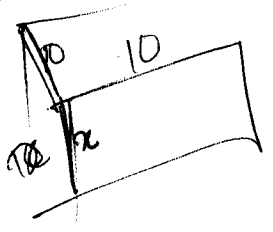
where m_0 is the rest mass of the neutron. [8 marks]

****END OF EXAMINATION****



$E = m_0c^2 + Mc^2$

$V_A = V_{A'} + V$



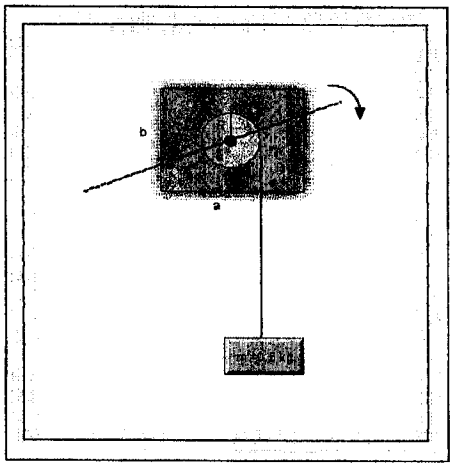


Figure 1:

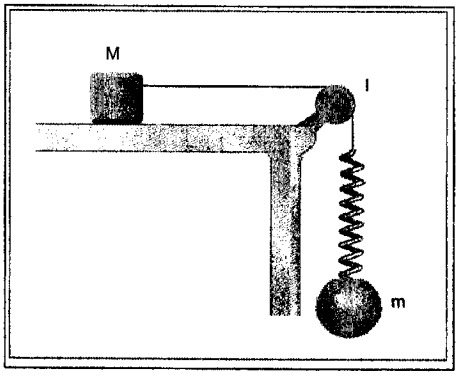


Figure 2:

THE UNIVERSITY OF ZAMBIA

DEPARTMENT OF PHYSICS

UNIVERSITY EXAMINATIONS – 2010

P272 – GEOMETRICAL AND PHYSICAL OPTICS

TIME: THREE HOURS

ANSWER: FIVE QUESTIONS
ALL QUESTIONS CARRY EQUAL MARKS

MAX. MARKS: 100

Q1. (a) State Fermat's principle of stationary time and use it to deduce the laws of reflection and refraction of light. [10 marks]

(b) If a convex lens having a refractive index 1.5 has a focal length of 20 cm in air of refractive index 1.00, what will be its focal length when it is immersed in water of refractive index 1.33? [5 marks]

(c) Find the radius of curvature of a convex lens if the distances of the object and the real image from it are 5 cm and 15 cm respectively. The angles of incidence and refraction of a ray of light passing from air of refractive index 1.00 into a convex surface of refractive index 1.52 are 60^0 and 45^0 respectively. [5 marks]

Q2. (a) Light containing two wavelengths λ_1 and λ_2 falls normally on a plano – convex lens of radius of curvature R resting on a glass plate. If the n^{th} dark ring due to λ_1 coincides with the $(n+1)^{th}$ dark ring due to λ_2, prove that the radius of the n^{th} dark ring of λ_1 is $\sqrt{\frac{\lambda_1\lambda_2 R}{\lambda_1-\lambda_2}}$

[10 marks]

(b) A glass wedge of angle 0.01 radian is illuminated by monochromatic light of 6000 Å falling normally on it. At what distance from the edge of the wedge will the 10^{th} fringe be observed by reflected light? [5 marks]

(c) In a Newton's rings experiment, the diameter of the third dark ring in the reflected system is 3.2 mm when light of wavelength 5890×10^{-8} cm falls on the apparatus. Find the radius of curvature of the lens surface in contact with the glass plate

[5 marks]

Q3. (a) Calculate the angle of emergence and the deviation when light is incident at 90^0 on the face of a 60^0 prism of refractive index 1.50. [5 marks]

(b) A thin can 14 cm high and 12 cm in diameter is filled with unknown liquid. An observer looking along a direction 25^0 above the horizontal can barely see the inside bottom edge of the can. Find the index of refraction of the liquid. [5 marks]

(c) An observer looks straight down into the same tin can described in question (b). What is the apparent depth of the liquid? [10 marks]

Q4. (a) Two optically flat glass plates, in contact along one edge, make a very small angle with each other. They are illuminated by red light of wavelength 750 nm and blue light of wavelength 450 nm. Looking down on the wedge the first place where it appears purple is 5.0 mm from the line of contact. If the red and blue light together produce purple light, find the angle between the plates. [10 marks]

(b) Wedge- air film is formed by placing aluminium foil between two glass slides at a distance 75 mm from the line of contact of the slides. When the air wedge is illuminated normally by light of wavelength 5.60×10^{-7} m, interference fringes are produced parallel to the line of contact with a separation of 1.20 mm. Calculate the angle of the wedge and thickness of the foil. [5 marks]

(c) Young's experiment is performed with light of the green mercury line of wavelength 551.06 nm. If the fringes are measured with a micrometer eye-piece 80 cm behind the double slit, it is found that 20 of them occupy a distance of 10.92 mm. Find the distance between the two slits. [5 marks]

Q5. (a) Newton's rings are formed by reflection in the air film between a plane surface and a spherical surface of radius of curvature 50 cm. If the diameter of the third bright ring is 0.0181 cm and the diameter of the twenty third bright ring is 0.501 cm, what is the wavelength of light used? [8 marks]

(b)Find the range of focal lens of a thin converging lens that achieves formation of the least possible distance between the object and its real image if the distance between the object and its real image is 40 cm. [4 marks]

(c) A parallel beam of sodium light is incident normally on a diffraction grating. The angle between the two first order spectra on either side of the normal is 27^0 42'. Assuming that the wavelength of light is 5.893×10^{-7} m, find
(i) the number of rulings per mm on the grating, and
(ii) the greatest number of bright images obtained. [8 marks]

Q6. (a) In a Newton's rings experiment, the diameter of the 10^{th} ring changes from 1.40 cm to 1.27 cm when a liquid is introduced between the lens and the plate. Calculate the refractive index of the liquid.

[8 marks]

(b) An object is placed between a plane mirror and a converging lens. The distance

between the lens and the mirror is 60 cm. The distance between the object and the plane mirror is 20 cm. Find any images the system forms left of the lens if its focal length is 30 cm. [6 marks]

(c) The glass prism has an angle A = 60^0 and a refractive index of 1.50. Calculate the angle of incidence for a minimum deviation, and the value of the minimum deviation, assuming the ray passes symmetrically through the prism. [6 marks]

Q7. Explain and discuss polarisation of light by

(a) a single glass plate [6 marks]

(b) a nicol prism [6 marks]

(c) reflection [8 marks]

The University of Zambia

Department of Physics

University Examination-2010

P302

(Computational Physics-II)

Instructions **Max. Marks 100**

- **Time allowed:** Three (3) Hours.
- **All questions carry equal marks.**
- Marks for each question are shown in the square brackets [ ].
- Whenever necessary, use the information given in the **appendix**
- **Answer**
  - i) Question one (1).
  - ii) Any three (3) questions form 2, 3, 4, 5 and 6.

Q.1 (a) What will be the output of the following expressions?

i) $x* = -2 * (y + z)/3$, given that $int\ x = 2$, $y = 3$, $z = 4$.

ii) $(3 * i - 2 * j)\%(2 * d - c)$, given that $int\ i = 8$, $j = 5$, $c = 99$, $d = 100$.

iii) $(x > y)$ && $(i > 0)$ && $(j < 5)$, given that $int\ i = 8$, $j = 5$; $float\ x = 0.005$, $y = -0.01$.

iv) $2 * x + y == 0$ given that $float\ x = 0.005$, $y = -0.01$.

v) $2 * ((i/5) + (4 * (j - 3))\%(i + j - 2))$, given that $int\ i = 8$, $j = 5$.

[5 Marks]

(b) Give short answers to the following questions

i) What are the two principal compents of a function definition?

ii) What is the difference between a **big-endian** and **small-endian** processor?

iii) What is the difference between the **while** and the **do-while** loop?

iv) What are the three classes of statements found in C?

v) What is the difference between the "=" and "==" operator?

[10 Marks]

(c) Show that the Universal gas constant $R = 8314$ is stored as 8312 as a floating-point number on a 2 bytes storage space when 4 bits are used for the exponent. Ignore the sign bits.

[10 Marks]

Q.2 Under the influence of air resistance, the velocity of a falling body of mass m is given by the equation

$$m\frac{dv}{dt} = kv^2 - mg$$

where g, acceleration due to gravity $= 9.8ms^{-2}$, $\frac{k}{m}$, drag coefficient that corresponds to a measure of air resistance $= 0.005$ with the positive y-direction upward and $y = 0$ at ground level. Initial condition is $v(0) = 0$.
Write, using the **do-while** loop, a C program that will do the following:

i) calculate the downward velocity as a function of time at intervals $\Delta t = 0.1s$.

ii) calculate the terminal velocity and the corresponding time,

iii) put the output in an output file with the name "fall.out" with the headings **Time** and **Velocity**

[25 Marks]

Q.3 **(a)** Write a C function subprogram to calculate the following function

$$f(x,t) = a + bx + cx^2 + \sin(\pi t)$$

a, b, and c are integer constants, 2, 5 and 1 respectively. x and t are float variables.

[5 Marks]

(b) Using the fuction subprogram in **(a)**, write a C program that will print the value of the function for the following values of x and t

x	0.2	0.5	0.7	0.8	1.0	1.3
t	0.1	0.3	0.6	0.7	0.9	1.0

[10 Marks]

(c) Write a C program to sum the following series

$$1+\left(\frac{1}{2}\right)^2+\left(\frac{1}{3}\right)^3+\left(\frac{1}{4}\right)^4+\left(\frac{1}{5}\right)^5+\left(\frac{1}{6}\right)^6+\left(\frac{1}{7}\right)^7+\left(\frac{1}{8}\right)^8+\left(\frac{1}{9}\right)^9+\left(\frac{1}{10}\right)^{10}$$

[10 Marks]

Q.4 **(a)** Solve the linear system $\mathbf{Ax} = \mathbf{b}$ using basic Gaussian elimination. Where

$$\mathbf{A} = \begin{bmatrix} 1 & 1 & 0 & 3 \\ 2 & 1 & -1 & 1 \\ 3 & -1 & -1 & 2 \\ -1 & 2 & 3 & -1 \end{bmatrix}, \mathbf{b} = \begin{bmatrix} 4 \\ 1 \\ -3 \\ 4 \end{bmatrix}$$

[10 Marks]

(b) The following data was obtained in an experiment in which a substance was observed to increase its mass with time.

mass(g)	138.6	268.3	400.1	481.5	701.0	896.1
time(s)	60	120	180	240	300	360

Write a C program that will;

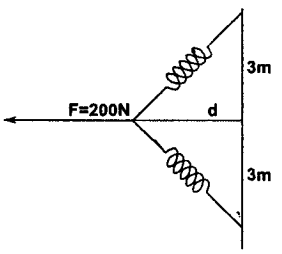
i) initialize the `mass` and `time` variables with the above data,

ii) use the least squares method to fit the above data to a curve $y = bx + a$, where y is the `mass` and x is the `time`.

What is the value of a and b?

[15 Marks]

Q.5 To determine the displacement d of a spring of stiffness 400 N/m and unstretched length 6 m when a force of 200 N is applied, as illustrated in the following figure.



i) By finding the tension T in both halves of the spring, show that the expression for the displacement d reduces to

$$4(\sqrt{9+d^2}-3)-\sqrt{9+d^2}/d=0$$

ii) Find d, correct to three decimal places, by finding the root of the equation in **(i)** using **five** iterations of the Netwon-Raphson method. Use an initial guess of $d = 1.2$.

iii) What is the absolute relative error after **five** iterations?

[25 Marks]

Q.6 The flow rate of an incompressible fluid in a pipe of radius $1m$ is given by

$$Q=\int_0^1 2\pi r V dr$$

where r is the distance from the center of the pipe and V is the velocity of the fluid.

i) Write a C program using the Trapezoidal method to find Q if only the following tabulated values of V are available;

r	0.0	0.2	0.4	0.6	0.8	1.0
V	1.0	0.96	0.84	0.64	0.36	0.0

ii) What is the value of Q?

[25 Marks]

******* **End of Examination** *******

Appendix

Commonly Used Library Funcitons

Funtion	Type	Purpose
`abs(i)`	`int`	Return the absolute value of `i`
`cos(d)`	`double`	Return the cosine of `d`
`exp(d)`	`double`	Raise e to the power `d` ($e = 2.7182818\ldots$)
`fabs(d)`	`double`	Return the absolute value of `d`
`log(d)`	`double`	Return the natural logarithm of `d`
`pow(d1,d2)`	`double`	Return `d1` raised to the `d2` power
`sin(d)`	`double`	Return sine of `d`
`sqrt(d)`	`double`	Return the square root of `d`
`tan(d)`	`double`	Return the tangent of `d`

Newton-Raphson

Given an equation $f(x) = 0$, the root can be obtained iteratively using the Newton-Raphson method:

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

Trapezoidal Method

The integral I of a function $f(x)$,

$$I = \int_a^b f(x)dx$$

can be approximated numerically using the Trapezoidal rule:

$$I = \frac{h}{2}\left[f(a) + f(b) + \sum_{i=1}^{N-1} f(x_i)\right]$$

where N is the number of strips (Trapezoids) in the interval $[a, b]$, $h = (b - a)/N$ is the step-size. And $x_i = a + ih$.

Simpson's Method

The integral I of a function $f(x)$,

$$I = \int_a^b f(x)dx$$

can be approximated numerically using Simpson's method using:

$$I = \frac{h}{3}\left[f(a) + f(b) + 2\sum_{i=1}^{\frac{N}{2}-1} f(x_{2i}) + 4\sum_{i=1}^{\frac{N}{2}} f(x_{2i-1})\right]$$

where N is an even number of strips in the interval $[a, b]$, $h = (b-a)/N$ is the step-size.

Euler's Method

Euler's method for finding the approximate solution of a first-order ODE, $y' = f(x, y)$, with initial condition$f(x_0) = y_0$, on an interval $[x_0, x_n]$ with step size $h = (x_n - x_0)/n$, is given by

$$y_{i+1} = y_i + hf(x_i, y_i)$$

to find the approximate values y_1, y_2, y_3,$\cdots$, y_n at the points $x_1 = x_0 + h$, $x_2 = x_0 + 2h$, $x_3 = x_0 + 3h$, $\cdots$, $x_n = x_0 + nh$.

Least square fit to a straight line

$$y = a + bx$$

$$a = \frac{\left(\sum_{i=1}^{N} y_i\right)\left(\sum_{i=1}^{N} x_i^2\right) - \left(\sum_{i=1}^{N} x_i\right)\left(\sum_{i=1}^{N} x_i y_i\right)}{N\sum_{i=1}^{N} x_i^2 - \left(\sum_{i=1}^{N} x_i\right)^2}$$

$$b = \frac{N\sum_{i=1}^{N} x_i y_i - \left(\sum_{i=1}^{N} x_i\right)\left(\sum_{i=1}^{N} y_i\right)}{N\sum_{i=1}^{N} x_i^2 - \left(\sum_{i=1}^{N} x_i\right)^2}$$

UNIVERSITY OF ZAMBIA

DEPARTMENT OF PHYSICS

2010 SECOND SEMESTER UNIVERSITY EXAMINATIONS

P332
STATISTICAL PHYSICS

DURATION: Three hours.

INSTRUCTIONS: Answer any four questions from the six given. *Each question carries 25 marks with the division of marks within each question indicated by the numbers in parenthesis next to the question.*

MAXIMUM MARKS: 100

DATE: Wednesday 21st April 2010.

Formulae that may be needed:

1.
$$f(a+h) = f(a) + \frac{h}{1!}f'(a) + \frac{h^2}{2!}f''(a) + \ldots + \frac{h^n}{n!}f^{(n)}(a) + \ldots$$

2.
$$\frac{1}{1-x} = 1 + mx + \frac{m(m+1)}{2!}x^2 + \frac{m(m+1)(m+2)}{3!}x^3 + \ldots$$

3.
$$\ln n! = n\ln n - n = n\ln\frac{n}{e}$$

4.
$$n! = \left(\frac{n}{e}\right)^n \sqrt{2\pi n}\left(1 + \frac{1}{12n} + \frac{1}{288n^2} + \ldots\right)$$

5.
$$P(E) = C\Omega(E)\Omega'(E^{(0)} - E)$$

6.
$$\beta(E) = \frac{\partial \ln \Omega(E)}{\partial E}$$

7.
$$\overline{\chi_\alpha} = -\frac{\overline{\partial E}}{\partial x_\alpha}$$

8.
$$\overline{dW} = \sum_{\alpha=1}^{n} \overline{\chi_\alpha} dx_\alpha$$

9.

$$F = E - TS = -\tau \ln Z, \quad \tau = \frac{1}{\beta} = kT$$

10.

$$S = -\left(\frac{\partial F}{\partial \tau}\right)_V, \qquad P = -\left(\frac{\partial F}{\partial V}\right)_\tau$$

11.

$$\int_0^\infty e^{-a^2x^2}\, dx = \frac{\pi^{\frac{1}{2}}}{2a}$$

12.

$$\sum_k e^{-E_k/\tau} \approx \int_0^\infty \int_{-\infty}^\infty \int_{-\infty}^\infty \int_{-\infty}^\infty e^{-(p_x^2+p_y^2+p_z^2)/2m\tau} \frac{1}{(2\pi\hbar)^3} dV dp_x dp_y dp_z \sum_k e^{-\epsilon_k/\tau}$$

13. Partition function for a classical ideal gas

$$Z = \left(\sum e^{-E_k/\tau}\right)^N$$

14. For a photon gas

$$\omega_i \approx \frac{\epsilon}{V^{\frac{1}{3}}},$$

and for a non-relativistic fermi gas

$$\omega_i \approx \frac{\eta}{V^{\frac{2}{3}}}$$

QUESTION 1

The probability $W(n)$ that an event characterized by a probability p occurs n times in N trials is given by the binomial distribution

$$W(n) = \frac{N!}{n!(N-n)!} p^n (1-p)^{N-n}. \tag{1}$$

Consider a situation where the probability p is small ($p << N$) and where one is interested in the case $n << N$. (Note that if N is large, $W(n)$ becomes very small if $n \to N$ because of the smallness of the factor p^n when $p << 1$. Hence $W(n)$ is indeed only appreciable when $n << N$.) Several approximations can then be made to reduce eq. (1) to a simpler form.

(a) Using the result $\ln(1-p) \approx -p$, show that $(1-p)^{N-n} \approx e^{-Np}$. (5 marks)

(b) Show that

$$\frac{N!}{(N-n)!} \approx N^n.$$

(10 marks)

(c) Hence show that eq. (1) reduces to

$$W(n) = \frac{\lambda^n}{n!} e^{-\lambda}, \tag{2}$$

where $\lambda = Np$ is the mean number of events. The distributioin (2) is called a "Poisson distribution".

(5 marks)

(d) Show that the poisson distribution, eq. (2), is properly normalized in the sense that $\sum_{n=0}^{N} W_n = 1$. (The sum can be extended to infinity to an excellent approximation, since W_n is negligibly small when $n \geq N$.)

(5 marks)

QUESTION 2

Show with detailed mathematical argument that the number of states $\Omega(E)$ in the energy interval E to $E + \delta E$ is related to E by

$$\Omega \propto E^f,$$

where f is the number of degrees of freedom. (25 marks)

QUESTION 3

(a) Consider two systems A and A' interacting thermally. Write down the condition for $P(E)$ to be a maximum and state what the condition corresponds to.

(3 marks)

(b) Define entropy S and then express the condition for $P(E)$ to be a maximum in terms of the entropy S of system A and entropy S' of system A'. (6 marks)

(c) State the integral condition for a differential to be exact both mathematically and in words. Use this condition, with an explanantion, to show whether or not the following quantities are exact or inexact differentials:

(i) Heat dQ (4 marks)

(ii) Entropy dS (4 marks)

(d) State the third law of thermodynamics and give a quantum mechanical argument that leads to the third law. (8 marks)

QUESTION 4

A vessel of volume V_1 contains N molecules of an ideal gas held at temperature τ and pressure P_1. The energy of a molecule may be written in the form

$$E_k(p_x, p_y, p_z) = \frac{p_x^2}{2m} + \frac{p_y^2}{2m} + \frac{p_z^2}{2m} + \epsilon_k$$

where ϵ_k denotes the energy levels corresponding to the internal states of the molecule of the gas. Evaluate the free energy F. Explicitely display the dependence on the volume V_1. (25 marks)

QUESTION 5

Consider the camonical distribution

$$P_r = \frac{e^{-\beta E_r}}{\sum_r e^{-\beta E_r}}.$$

(a) Write down the expression for the mean energy $\overline{E}$. Give the definition of the partition function Z, and then rewrite $\overline{E}$ in terms of Z. (4 marks)

(b) Derive the expresson for the dispersion $\overline{(\Delta E)^2}$. (10 marks)

(c) Derive an expression for the mean work $\overline{dW}$ in terms of Z. From your result write down the generalized force $\overline{\chi}$ in terms of Z. Consider only one external parameter in your derivation. (11 marks)

QUESTION 6

For a photon gas the entropy is

$$S = \frac{1}{T}\sum_i \frac{\hbar\omega_i}{e^{\hbar\omega_i/T}-1} - \sum_i \ln(1-e^{-\hbar\omega_i/T}), \tag{1}$$

where ω_i is the angular frequency of the ith mode. Using (1):

(a) Show that the isothermal work done by the gas is

$$dW = -\sum_i n_i \hbar \frac{d\omega_i}{dV} dV,$$

where n_i is the average number of photons in the ith mode. (12 marks)

(b) Show that the radiation pressure is equal to one third of the energy density:

$$P = \frac{1}{3}\frac{E}{V}.$$

(7 marks)

(c) Show that for a non-relativistic Fermi gas the pressure is

$$P = \frac{2}{3}\frac{E}{V}.$$

(6 marks)

END

The University of Zambia

Department of Physics

Second Semester University Examination - 2009/2010

Digital Electronics I – P342

Duration: Three hours (180 min)

Date: 30th April 2010

Full Marks: 100

Time: 9:00 – 12:00 hrs

Instructions

- **Use only your COMPUTER NUMBER on your answer sheets and NOT your name.**
- **This paper contains Six (6) questions. Each question carries 25 marks.**
- **Attempt any Four (4) out of the Six (6) questions given in this examination paper.**
- **This paper has a total of 100 marks. All questions carry equal marks.**
- **Show all your work clearly. Omission of essential work will result in a loss of marks.**
- **Marks allocated for each question are indicated in square brackets [ ].**

1. **(a)** Apply suitable Boolean laws and theorems to modify the expression for a two-input EX-OR gate in such a way as to implement a two-input EX-OR gate by using the minimum number of two-input NAND gates only. **[8]**

(b) Draw the resulting logic circuit/diagram. **[2]**

(c) Design a mod-8 Ripple Counter. **[4]**

Explain how it can be converted into a mod-8 ring counter. **[2]**

(d) Simplify $(AB + CD)\left[\left(\overline{A} + \overline{B}\right)\left(\overline{C} + \overline{D}\right)\right]$. **[5]**

(e) Figure 1 below shows a standard TTL NAND gate. Describe how this gate behaves when

i) the inputs A and B are both LOW,

ii) either input A or B is LOW while the other input is in HIGH state,

iii) both A and B are HIGH, giving details of how various components like diodes and transistors assume cut-off (OFF) and saturation (ON) states as well as the logic state of the output Y in each of the above three listed input cases. **[4]**

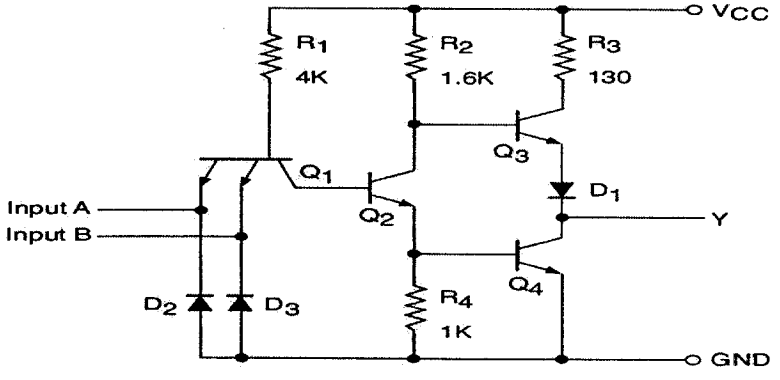


Figure 1 Standard TTL NAND gate.

2. **(a)** Design a 4-bit Shift Register using D-type flip-flops. Show its flip-flop's associated transitions with respect to the D_0 input and the clock signal pulses considering that $Q_0 = 1$ while $Q_1=Q_2=Q_3= 0$ initially. **[5]**

(b) Prove that A.B + A'.B + A'.B' = A' + B. **[3]**

(c) Given A = 65/4 and B = 3/2, convert A and B to both decimal and binary form, and then evaluate A multiplied by B and A divided by B in both decimal and binary forms. **[10]**

(d)

i. Distinguish between a half-adder and a full adder. **[2]**

ii. Distinguish between the 1's complement and 2's complement method of Subtraction. **[2]**

iii. Subtract 1101 from 1001 by using the 1's Complement method. **[1]**

(e) Show, by drawing, 2 different NOT gate diagrammatic realisations formed by using a single NAND gate in each case. **[2]**

3. **(a)** The term "fan-out" refers to the number of similar inputs logic gates that a particular logic gate can drive properly without seriously changing its voltage levels when they are connected to its output. What are the factors that limit the "fan-out" of a logic gate? **[2]**

(b) Explain how a transistor operates as a switch, and include a diagram and its characteristics showing transistor operating regions. **[4]**

(c) Suppose a serial-in-parallel-out (SIPO) shift register is required to store the binary bits 0110 in it

i. How many flip-flops must it contain? **[1]**

ii. How many clock pulses are required to accomplish the desired storage? **[2]**

iii. Show the states of the register (use waveforms) for the various flip-flops given that the register initially contains all 1s. **[2]**

(d)

i. Distinguish between randomly accessed memories and sequentially accessed memories and give one example of each. **[2]**

ii. For the Boolean function f(A,B) = Σ0,2: prove that

1. f(A,B) = Π 1,3 **[3]**
2. f'(A,B) = Σ1,3 = Π0,2. **[3]**

(e) Describe how the negative logic gate below (Figure 2) operates? What logic gate function does it perform? If Positive logic is to be used, what gate function would the same diagram below perform? **[6]**

Hint: Negative logic is being used here and assume that all source resistances R_s are zero Ohms.

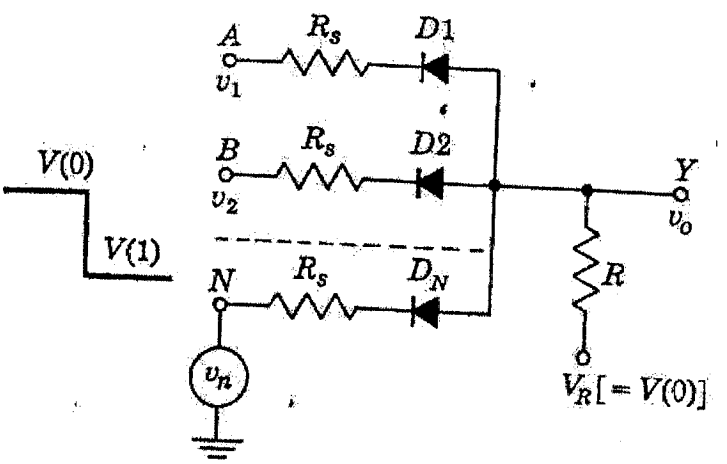


Figure 2: Negative logic gate circuit.

4. **(a)** The JK flip-flop block diagram is shown below. Explain how it operates. Also, indicate the output generated by sets of the LOW (0) and HIGH (1), HIGH (1) and LOW (0), and HIGH (1) and HIGH (1) inputs at the J and K terminals respectively. **[7]**

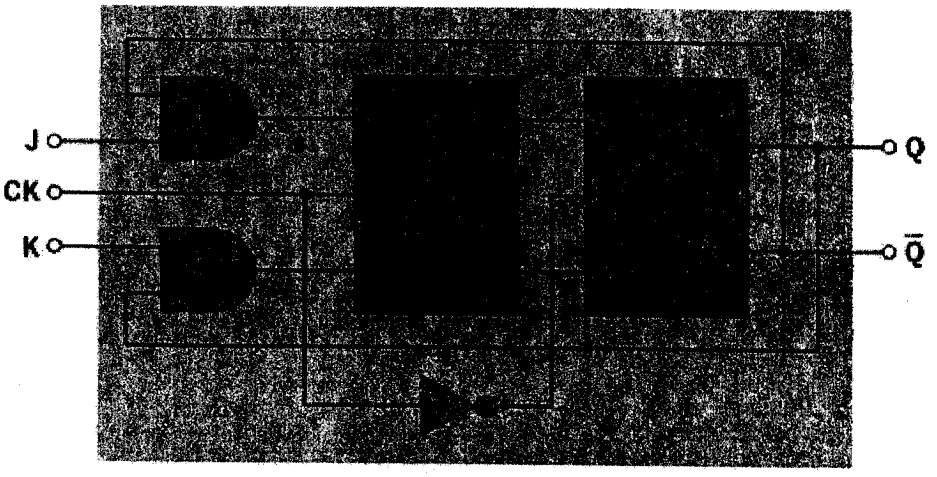


Figure 3: JK flip-flop block diagram.

(b) Given the logical function of three variables

$$f(A,B,C) = A + \overline{B}C$$

express f in the standard product of sums form. **[4]**

(c) The Difference Amplifier configuration forms a critical part of the emitter coupled logic (ECL) gate systems. Draw the Difference Amplifier circuit and describe how the Difference Amplifier operates. **[5]**

(d) Find the Dual of $XY(Y+Z+X)+X\overline{Y}$. **[2]**

(e)

i. The arithmetic logic unit (ALU) is the core component of all microprocessors. What is the primary function of the ALU in a microprocessor? **[2]**

ii. Using a NOT gate, some AND gates and an OR gate, design a Half-Adder circuit considering that it can be implemented by taking $Sum = A \oplus B$ and $Carry = AB$. **[5]**

5. **(a)** Draw circuit diagrams to show how a NOR gate can be converted into a NOT gate. **[2]**

(b) Find the

i. Sum of $(AECF1)_{16}$ and $(15ACD)_{16}$. **[2]**

ii. Complement of $\left[\left(A\overline{B}+\overline{C}\right)D+\overline{E}\right]\overline{F}$. **[5]**

(c) Distinguish between an astable and a bistable multivibrator in terms of operation and configuration of the electronic components in view of the laboratory experiments done in this **P342** course. Why is the latter called a memory element (or flip-flops)? **[5]**

(d) Determine the output for the Figure 4 below and simplify it using De Morgan's Theorem. **[2]**

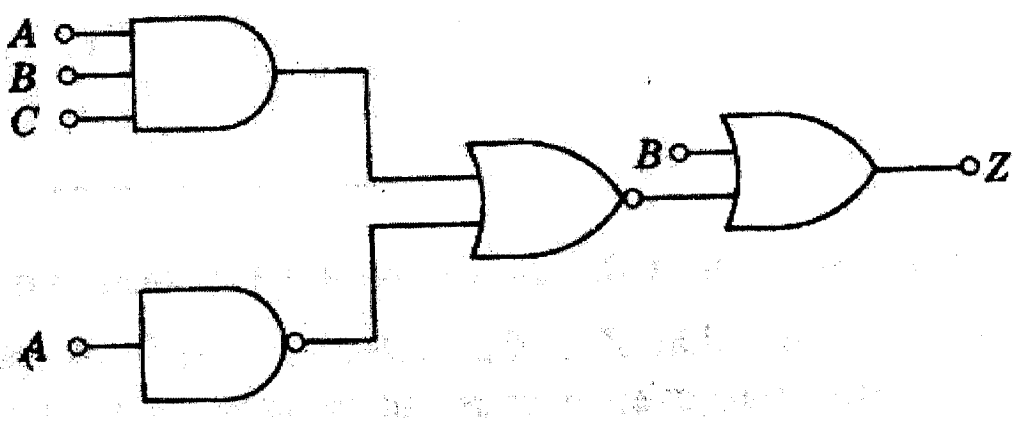


Figure 4: Circuit of logic gates.

(e) Distinguish between a multiplexer and demultiplexer? **[2]**

(f) Draw the microprocessor structure with its associated components. Write short notes on the "register file" of the microprocessor. **[7]**

6. (a) Design a 3-bit R and 2R ladder digital-to-analogue (D/A) converter. **[6]**

(b) Using 2's Complement, subtract 101 from 111 and check the result by using the conventional method. **[2]**

(c) Draw a block diagram of a sixteen word four bit RAM paying particular attention to the following: data input and output lines, write enable line(s), Address lines before the Address decoder, Address lines after the decoder. **[5]** Describe the process of writing and reading a word at a particular location. **[3]**

(d) Implement a full adder circuit using a 3-to-8 line decoder. **[5]**

(e) Express the output of the following truth table in minterms. Draw the corresponding logic circuit. **[5]**

Table 1: Truth table for a logic circuit

A	B	C	Y (=Output)
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

END OF EXAMINATION

UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF PHYSICS

2009/2010 UNIVERSITY EXAMINATIONS

P 422: SOLID STATE PHYSICS II

DATE: MAY 10, 2010

DURATION: THREE HOURS

TOTAL MARKS: 100

ANSWER ANY FOUR QUESTIONS

ALL WORKING SHOULD BE SHOWN CLEARLY TO EARN FULL CREDIT.

A SHEET OF FORMULAE IS ATTACHED AT THE BACK OF THE QUESTION PAPER.

QUESTION ONE

(a) Explain why metallic bodies are always opaque but glass for example is transparent? **[5]**

(b) The electron and hole mobilities in a Si sample are 0.135 and 0.048 m^2/Vs respectively.

I. Determine the conductivity of intrinsic Si at 300 K if the intrinsic carrier concentration is 1.5×10^{16} atoms/m^3. **[3]**

II. The sample is then doped with 10^{23} phosphorus atoms/m^3. Determine the equilibrium hole concentration, conductivity and the Fermi level relative to the intrinsic level **[6]**

III. Hence find the resistance of the Si rod 1 cm long, 1 mm wide and 1 mm thick at temperature of 300K. μ_n =1350 cm^2/Vs and μ_h =480 cm^2/Vs **[3]**

(c) Show that the conductivity of a semiconductor is minimum when it is lightly doped with P type impurity such that

I. $$P = n_i\sqrt{\frac{\mu_n}{\mu_p}}$$ **[4]**

II. Show that the minimum conductivity is $2n_i\sqrt{\mu_n\mu_p}q$. **[2]**

III. Hence determine the value of the minimum conductivity of Si. **[2]**

QUESTION TWO

(a) What is the difference between a conductor cooled to 0 K and a superconductor? Explain in terms of the Meissner effect and the disappearance of resistivity. **[5]**

(b) Explain the following (include formulae in some).

(i) Persistent current (ii) Meissner effect (iii) Isotope effect
(iv) Cooper pairs **[10]**

(c) The critical fields at 6 K and 8 K for a NbTi alloy are 7.616 and 4.284 MAm^{-1} respectively. Determine the transition temperature and the critical field at 0 K. **[10]**

QUESTION THREE

(a) Clearly distinguish between diamagnetism, paramagnetism and ferromagnetism. **[6]**

(b) Nickel has an atomic number of 28. Compute the effective number of Bohr magnetons for nickel ion Ni^{++}

(i) if the orbital angular momentum is not quenched **[5]**

(ii) if it is quenched. **[3]**

(b) (i) Show that the exchange integral (coefficient) J_e is given by

$$J_e = \frac{3k_B T_C}{2ZS(S+1)}$$

for a ferromagnet with Curie temperature T_C. Each atom has Z identical nearest neighbours and each has spin S. **[6]**

(ii) Hence calculate the exchange integral for nickel which has a face centred cubic structure and a Curie temperature of 631 K. **[3]**

(iii) Calculate the internal field also. **[2]**

QUESTION FOUR

(a) (i) What is the Bloch theorem? **[2]**

(ii) Prove that the number of different k-states in the first Brillouin zone of a simple cubic lattice is equal to the number of lattice states. **[6]**

(b) Using the Kronig-Penney model, show that for $P \ll 1$, the energy of the lowest energy band is

$$E = \frac{\hbar^2 P}{ma^2}$$ **[6]**

(c) (i) Show that the effective mass of an electron is inversely proportional to the second derivative of the E-k curve. **[6]**

(ii) Discuss the conditions when the effective mass of an electron becomes positive, negative and infinity. **[5]**

QUESTION FIVE

(a) (i) What is the relationship between the ***s-shell*** and a ***d-shell*** in terms of magnetism and electrical conductivity? **[2]**

(ii) Explain the difference between type I and type II superconductors using the Meissner effect. Prove that the Meissner effect and the disappearance of resistivity are mutually consistent. **[5]**

(b) (i) Show that the super current density which results from the AC Josephson effect observed in superconductors is

$$J = J_0 \sin\left(\delta(0) + \frac{2eVt}{\hbar}\right).$$

Where J_0 is the maximum zero-voltage current that can be passed by the junction, V is the voltage across the junction. **[10]**

(ii) Hence find the ratio of the electronic charge and Plank's constant if the measured current oscillates at 725 Mhz when a DC voltage, V=1.5 μV is applied across the junctions.

[2]

(c) Determine the magnitude of the total angular momentum quantum number J for the following using the Hund rules:

(i) Ce^{3+} with outer shell configuration, $4f^1 5s^2 P^6$; **[3]**

(ii) Pr^{3+} with outer shell configuration, $4f^2 5s^2 P^6$. **[3]**

QUESTION SIX

(a) (i) What is the cause of the macroscopic magnetic properties of materials? **[3]**

(ii) What is spontaneous magnetization? **[2]**

(b) (i) What is Hall Effect? Mention some uses of Hall Effect. **[3]**

(ii) In a particular semiconductor there are 10^{23} donors/cm^3 with an ionization energy of 1 meV and an effective mass of $0.01m_0$, where m_0 is the rest mass of an electron.

Estimate the concentration of conduction electrons at 4 K. **[6]**

Hence what is the Hall coefficient? (Assume no acceptor atoms present and that $E_g >> kT$) **[2]**

(c) The wave function of the hydrogen atom in its ground state (1s) at S.T.P is

$$\Psi(r) = \frac{1}{\sqrt{\pi a_0^{\,3}}} \exp\left(-\frac{r}{a_0}\right)$$

where $a_0 = 0.529 \times 10^{-8}$ cm is the atomic radius. Show that for this state,

$\langle r^2 \rangle = 3a_0^{\,2}$. **[6]**

Hence calculate the diamagnetic susceptibility of atomic hydrogen. **[3]**

FORMULAE AND CONSTANTS YOU MAY NEED

Electron rest mass $m_e = 9.109 \times 10^{-31}$ kg Electron charge $e = 1.602 \times 10^{-19}$ C

Planck's constant $h = 6.626 \times 10^{-34}$ Js^{-1} Bolzmann constant $k_B = 1.381 \times 10^{-23}$ JK^{-1}

Avogadro's number $N_A = 6.022 \times 10^{23}$/g mole Bohr magneton $\mu_B = 9.274 \times 10^{-24}$ Am^2

Permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ Hm^{-1}

$$M = Ng\mu_B JB_J(y) \text{ where } y = \left(\frac{g\mu_B JB}{k_B T}\right) \qquad B_J(y) \approx \frac{y(J+1)}{3J} \text{ for } y << 1$$

Curie temperature for a ferromagnet,

$$T_C = \frac{\lambda N g^2 \mu_B{}^2 J(J+1)}{3k}$$

Exchange energy $U_i = -gS_{zi}\mu_B \lambda \mu_0 M$ OR $U_i = -\frac{2ZJ_e S_{zi} M}{g\mu_B N}$

$$\mu = IA$$

$$N_C = 2\left[\frac{2\pi m_n{}^* kT}{h^2}\right]^{\frac{3}{2}} \qquad N_V = 2\left[\frac{2\pi m_h{}^* kT}{h^2}\right]^{\frac{3}{2}}$$

Effective number of electrons and holes at the conduction and valence band edge respectively.

$$n = [N_C N_V]^{\frac{1}{2}} \exp\left(\frac{E_d - E_C}{2kT}\right) \quad \text{OR} \quad n = n_i \exp\left(\frac{E_f - E_i}{kT}\right)$$

Diamagnetic susceptibility

$$\chi_{dia} = -\frac{N\mu_0 Ze^2}{6m}\langle r^2 \rangle$$

$$\int_0^\infty x^4 e^{-x} dx = 24$$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF NATURAL SCIENCES

2010 ACADEMIC YEAR SECOND SEMESTER
FINAL EXAMINATIONS

P442: DIGITAL ELECTRONICS II

Time: Three Hours **Maximum Marks = 100**

Attempt any four questions.
All questions carry equal marks.
The marks are shown in brackets.

8085 / 8080A Instruction summary by Functional Groups

DATA TRANSFER (COPY)

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
40	MOV B,B	58	MOV E,B	70	MOV M,B	1A	LDAX D
41	MOV B,C	59	MOV E,C	71	MOV M,C	2A	LHLD
42	MOV B,D	5A	MOV E,D	72	MOV M,D	3A	LDA
43	MOV B,E	5B	MOV E,E	73	MOV M,E	02	STAX B
44	MOV B,H	5C	MOV E,H	74	MOV M,H	12	STAX D
45	MOV B,L	5D	MOV E,L	75	MOV M,L	22	SHLD
46	MOV B,M	5E	MOV E,M	77	MOV M,A	32	STA
47	MOV B,A	5F	MOV E,A	78	MOV A,B	01	LXI B
48	MOV C,B	60	MOV H,B	79	MOV A,C	11	LXI D
49	MOV C,C	61	MOV H,C	7A	MOV A,D	21	LXI H
4A	MOV C,D	62	MOV H,D	7B	MOV A,E	31	LXI SP
4B	MOV C,E	63	MOV H,E	7C	MOV A,H	F9	SPHL
4C	MOV C,H	64	MOV H,H	7D	MOV A,L	E3	XTHL
4D	MOV C,L	65	MOV H,L	7E	MOV A,M	EB	XCHG
4E	MOV C,M	66	MOV H,M	7F	MOV A,A	D3	OUT
4F	MOV C,A	67	MOV H,A	06	MVI B	DB	IN
50	MOV D,B	68	MOV L,B	0E	MVI C	C5	PUSH B
51	MOV D,C	69	MOV L,C	16	MVI D	D5	PUSH D
52	MOV D,D	6A	MOV L,D	1E	MVI E	E5	PUSH H
53	MOV D,E	6B	MOV L,E	26	MVI H	F5	PUSH PSW
54	MOV D,H	6C	MOV L,H	2E	MVI L	C1	POP B
55	MOV D,L	6D	MOV L,L	36	MVI M	D1	POP D
56	MOV D,M	6E	MOV L,M	3E	MVI A	E1	POP H
57	MOV D,A	6F	MOV L,A	0A	LDAX B	F1	POP PSW

ARITHMETIC

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
80	ADD B	CE	ACI	D6	SUI	23	INX H
81	ADD C	90	SUB B	DE	SBI	33	INX SP
82	ADD D	91	SUB C	09	DAD B	05	DCR B
83	ADD E	92	SUB D	19	DAD D	0D	DCRC
84	ADD H	93	SUB E	29	DAD H	15	DCR D
85	ADD L	94	SUB H	39	DAD SP	1D	DCR E
86	ADD M	95	SUB L	27	DAA	25	DCR H
87	ADD A	96	SUB M	04	INR B	2D	DCR L
88	ADC B	97	SUB A	0C	INR C	35	DCR M
89	ADC C	98	SBB B	14	INR D	3D	DCR A
8A	ADC D	99	SBB C	1C	INR E	0B	DCX B
8B	ADC E	9A	SBB D	24	INR H	1B	DCX D
8C	ADC H	9B	SBB E	2C	INR L	2B	DCX H
8D	ADC L	9C	SBB H	34	INR M	3B	DCX SP
8E	ADC M	9D	SBB L	3C	INR A		
8F	ADC A	9E	SBB M	03	INX B		
C6	ADI	9F	SBB A	13	INX D		

LOGICAL

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
37	STC	A9	XRA C	B3	ORA E	BD	CMP L
A0	ANA B	AA	XRA D	B4	ORA H	BE	CMP M
A1	ANA C	AB	XRA E	B5	ORA L	BF	CMP A
A2	ANA D	AC	XRA H	B6	ORA M	FE	CPI
A3	ANA E	AD	XRA L	B7	ORA A	07	RLC
A4	ANA H	AE	XRA M	F6	ORI	0F	RRC
A5	ANA L	AF	XRA A	B8	CMP B	17	RAL
A6	ANA M	EE	XRI	B9	CMP C	1F	RAR
A7	ANA A	B0	ORA B	BA	CMP D	2F	CMA
E6	ANI	B1	ORA C	BB	CMP E	3F	CMC
A8	XRA B	B2	ORA D	BC	CMP H		

BRANCHING

Hex	Mnemonic	Hex	Mnemonic	Hex	Mnemonic
C3	JMP	D7	RST 2	EC	CPE
C2	JNZ	DF	RST 3	F4	CP
CA	JZ	E7	RST 4	FC	CM
D2	JNC	EF	RST 5	C9	RET
DA	JC	F7	RST 6	C0	RNZ
E2	JPO	FF	RST 7	C8	RZ
EA	JPE	CD	CALL	D0	RNC
F2	JP	C4	CNZ	D8	RC
FA	JM	CC	CZ	E0	RPO
E9	PCHL	D4	CNC	E8	RPE
C7	RST 0	DC	CC	F0	RP
CF	RST 1	E4	CPO	F8	RM

CONTROL

Hex	Mnemonic
00	NOP
76	HLT
F3	DI
FB	EI
20	RIM
30	SIM

Q1. (a) Differentiate between DRAM and SRAM. [9]

(b) A certain memory has a capacity of 32K×16. [4]

(i) How many bits are there in each word?

(ii) How many words are being stored?

(iii) How many data input and data output lines does it have?

(iv) How many address lines does it have?

(c) (i) What is PLD? What does an 'x' represent on a PLD diagram? What does a '**dot**' represent on a PLD diagram? Illustrate with an example. [4]

(ii) Using the connection abbreviations, show how a PLA can be programmed to implement the functions

$$F_1 = A\overline{B}\,\overline{C} + ABC \quad \text{and} \quad F_2 = ABC + \overline{A}\,\overline{B} + A\overline{C}$$ [8]

Q2. (a) Reduce the following expression

$$f = \Pi\, M(0,3,7,8,9,10,11,15) \cdot d(2,4)$$

and implement it in NOR logic. [8+5]

(b) Describe how a computer uses the bootstrap program? [6]

(c) How many gate inputs are required to realize the following expressions? [6]

(i) $WX\overline{Y} + WXZ + VUX + XY\overline{Z}\,W$

(ii) $A\left(B+\overline{D}\right)\left(A+C+E\right)\left(B+\overline{C}+\overline{D}+E\right)$ [6]

Q3. A system is designed to monitor the temperature of a furnace. Temperature readings are recorded in sixteen bits and stored in memory locations starting at 8060H. The higher order byte is stored first and the lower order byte is stored in the next consecutive memory locations. However, the higher order byte of all the temperature readings is constant. [25]

Draw the flowchart and write a program to transfer low order readings to consecutive memory locations starting at 8080H and discard the higher order bytes.

Temperature Readings (H): 0581, 0595, 0578, 057A, 0598

Q4. (a) Without reducing, implement the following expression in AOI logic and then convert them into (i) NAND logic and (ii) NOR logic. [15]

$$AB + CD\left(A\overline{B} + CD\right)$$

(b) Write a program to meet the following. [10]

(i) Load the data byte 8EH in register D.
(ii) Load the data byte F7H in register E.
(iii) Mask the higher order bits (D_7-D_4) from both the data bytes.
(iv) Exclusive OR the low order bits (D_3-D_0) from both the data bytes.
(v) Display the answer at two output ports.

Q5. (a) Explain interrupt driven data transfer scheme with an example. [14]

(b) Read the following instructions and specify register contents and the status of S, Z and CY after the execution of instructions. Assume all flags are cleared initially. [5]

```
MVI A,00H
ORA A
SUI 01H
HLT
```

(c) Explain the functions of the following signals of 8085 microprocessor. [6]

(i) RESET (ii) READY (iii) HOLD

Q6. (a) Minimize the following multiple output functions using K-map. [19]

$$f_1(X_1, X_2, X_3, X_4) = \Sigma m(1, 2, 3, 5, 7, 8, 9) + d(12, 14)$$
$$f_2(X_1, X_2, X_3, X_4) = \Sigma m(0, 1, 2, 3, 4, 6, 8, 9) + d(10, 11)$$
$$f_3(X_1, X_2, X_3, X_4) = \Sigma m(1, 3, 5, 7, 8, 9, 12, 13) + d(14, 15)$$

(b) Write short notes on [6]

(i) MROM (ii) Cache controller

END OF P442 EXAMINATION

THE UNIVERSITY OF ZAMBIA
PHYSICS DEPARTMENT
UNIVERSITY OF ZAMBIA
SECOND SEMESTER EXAMINATIONS 2010
P455 QUANTUM MECHANICS II

TIME: THREE HOURS
ANSWER: ANY FOUR QUESTIONS
MAXIMUM MARKS: 100

$$E_n^{(2)} = \sum_{k \neq n} \frac{\left|H'_{kn}\right|^2}{E_n^{(0)} - E_k^{(0)}}$$

$$\begin{vmatrix} H'_{11} - E^{(1)} & H'_{12} & \ldots & H'_{1\alpha} \\ H'_{21} & H'_{22} - E^{(1)} & \ldots & H'_{2\alpha} \\ \ldots & \ldots & \ldots & \ldots \\ H'_{\alpha 1} & H'_{\alpha 2} & \ldots & H'_{\alpha\alpha} - E^{(1)} \end{vmatrix} = 0$$

In terms of the Pauli spin matrices σ_x, σ_y and σ_z, the spin-1/2 operators

$$S_x = \frac{\hbar}{2}\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} = \frac{\hbar}{2}\sigma_x, \quad S_y = \frac{\hbar}{2}\begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} = \frac{\hbar}{2}\sigma_y$$

$$S_z = \frac{\hbar}{2}\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} = \frac{\hbar}{2}\sigma_z, \quad S^2 = \frac{3}{4}\hbar^2\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} = \frac{3}{4}\hbar^2 I$$

The harmonic oscillator eigenfunctions are

$$\psi_0(x) = \left(\frac{\alpha}{\sqrt{\pi}}\right)^{1/2} e^{-\frac{1}{2}\alpha^2 x^2}, \quad \psi_1(x) = \left(\frac{\alpha}{2\sqrt{\pi}}\right)^{1/2} 2\alpha x e^{-\frac{1}{2}\alpha^2 x^2}$$

where

$$\alpha = \left(\frac{m\omega}{\hbar}\right)^{1/2}$$

The eigenfunctions of a particle in a box are

$$\psi_n(x) = \sqrt{\frac{2}{L}} \sin\frac{n\pi x}{L}, \text{ with energies } E_n = \frac{\pi^2\hbar^2 n^2}{2mL^2}, \quad n = 1, 2, 3, \ldots..$$

and are orthonormal.

The harmonic oscillator matrix elements for x are

$$x_{nm} = \begin{cases} 0, & m \neq n \pm 1 \\ \frac{1}{\alpha}(\frac{n+1}{2})^{1/2}, & m = n+1 \\ \frac{1}{\alpha}(\frac{n}{2})^{1/2}, & m = n-1 \end{cases}, \text{where } \alpha = \left(\frac{m\omega}{\hbar}\right)^{1/2}$$

The first-order transition probability amplitude is

$$c_{ba}^{(1)} = (i\hbar)^{-1} \int_{t_0}^{t} H'_{ba}(t') \exp(i\omega_{ba}t')dt'$$

where

$$H'_{ba}(t) = \left\langle \psi_b^{(0)} \left| H'(t) \right| \psi_a^{(0)} \right\rangle \text{ and } \omega_{ba} = \frac{E_b^{(0)} - E_a^{(0)}}{\hbar}$$

Useful integrals

$$\int xe^{-\alpha x^2} dx = -\frac{1}{2\alpha} e^{-\alpha x^2} + C$$

$$\int_{-\infty}^{\infty} e^{-bx^2} dx = \sqrt{\frac{\pi}{b}}$$

$$\int_{-\infty}^{\infty} x^2 e^{-bx^2} dx = \frac{1}{2}\sqrt{\frac{\pi}{b^3}}$$

Question 1

(a) **(i)** Show that the expression for the first-order energy correction in non-degenerate time-independent perturbation theory is

$$E_n^{(1)} = \left\langle \psi_n^{(0)} \left| H' \right| \psi_n^{(0)} \right\rangle$$

where H' is the perturbation. [5 marks]

(ii) A particle moving in a one-dimensional potential well with walls at $x = 0$ and $x = L$ is acted upon by the perturbation $H' \doteq \lambda p_x$. Find the corrections to the energies of the states up to second order. [10 marks]

(b) An electron vibrating in simple harmonic motion is in the first excited state. A perturbing uniform electric field λ with time dependence $\exp(-t/T)$, where T is a constant, is switched on at $t = 0$, so that the electron is subjected to the perturbation

$$H' = -e\lambda x e^{-t/T}$$

until $t = \infty$.

(i) Determine the allowed transitions. [2 marks]

(ii) Determine the probability of de-excitation to the ground state. [8 marks]

Question 2

(a) The x component L_x of the orbital angular $\mathbf{L}$ commutes with L^2, the square of the total momentum. Therefore, simultaneous eigenfunctions of these two operators are possible. These functions, denoted by W_{lm}, therefore satisfy the eigenvalue equations

$$L_x W_{lm} = m\hbar W_{lm}$$

and

$$L^2 W_{lm} = l(l+1)\hbar^2 W_{lm}$$

Here, $m = -l, -l+1, ..., l-1, l$.

(i) Show that in the $\{W_{lm}\}_{m=-1}^{m=l}$ representation, the matrix treatment of orbital angular momentum $l = 1$ gives

$$[L_x] = \hbar \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

and

$$[L^2] = 2\hbar^2 \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

and obtain the matrix forms of the eigenvectors. [9 marks]

(ii) Obtain the eigenvectors of these [redacted] operators. [3 marks]

(iii) Show that the matrix form of the operator $O = L_y^2 + L_z^2$ is

$$[O] = \hbar^2 \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

[3 marks]

(b) The Hamiltonian of an electron in a magnetic field B is

$$H = \frac{1}{\sqrt{2}} \mu_B B(\sigma_x + \sigma_y)$$

where σ_x and σ_y are Pauli spin operators.

(i) Calculate the energy in the ground state. [4 marks]

(ii) Calculate the expectation value of S_y in the ground state. [6 marks]

Question 3

(a) The Hamiltonian of a rigid rotator of moment of inertia I is given by

$$H = -\frac{\hbar^2}{2I} \frac{d^2}{d\phi^2}$$

where ϕ is the angle of rotation about the z axis and $0 \leq \phi \leq 2\pi$.

(i) Show that the eigenfunctions of the systems are

$$\psi_n(\phi) = \frac{1}{\sqrt{2\pi}} e^{in\phi}, \quad n = 0, \pm 1, \pm 2, ...$$

and that the energy eigenvalues are

$$E_n = \frac{\hbar^2 n^2}{2I}$$

and are therefore doubly degenerate except for the ground state. [10 marks]

(b) The rotator has an electric dipole moment $\mathbf{d}$ and is placed in a homogeneous electric field $\boldsymbol{\epsilon}$ in the z direction. Hence it is perturbed by the potential

$$H' = -\boldsymbol{\epsilon} \cdot \mathbf{d} = -\epsilon d \cos\phi$$

Show that the first-order corrections to all the energy levels vanish. [15 marks]

Question 4

(a) The use of the variational method for estimating ground-state energies and eigenfunctions is based on the result

$$\langle E \rangle \geq E_0$$

where E_0 is the ground-state energy and $\langle E \rangle$ is the expectation value of the Hamiltonian for a selected trial function. Prove this result. [6 marks]

(**b**) A particle of mass m moves in the one-dimensional V-shaped potential

$$V(x) = -bx, \quad x \leq 0$$
$$V(x) = bx, \quad x \geq 0$$

where b is a positive constant. Since the potential is symmetric about the origin, the eigenfunctions are of definite parity, and in particular, the ground state must be of positive parity. Moreover, since the potential is such $V(x) \underset{x \to \pm\infty}{\to} \infty$ the eigenfunctions must vanish at $\pm\infty$. Trial functions that obey these properties are likely to give the best estimates to the ground-state energy. One such trial function is

$$\phi_\alpha(x) = e^{-\alpha x^2},$$

where α is the variational parameter.

(**i**) Sketch the potential and explain why the energy eigenvalues of the system are positive. [4 marks]

(**ii**) Show that the expectation value of the Hamiltonian is

$$\langle H(\alpha) \rangle = \frac{\hbar^2}{m}\alpha + \frac{b}{\sqrt{2\pi\alpha}}$$

[9 marks]

(**iii**) Hence show that the best estimate of the ground-state energy of the particle is

$$E_0 = \left(\frac{4b^2\hbar^2}{\pi m}\right)^{1/3}$$

[4 marks]

(**iv**) Write down the approximate ground-state eigenfunction. [2 marks]

Question 5

(**a**) The Hamiltonian of the harmonic oscillator is

$$H = \frac{p^2}{2m} + \frac{1}{2}kx^2$$

(**i**) Show that in terms of the ladder operators

$$a_\pm = \frac{1}{\sqrt{2}}\left[\frac{p}{(m\hbar\omega)^{1/2}} \pm i\left(\frac{m\omega}{\hbar}\right)^{1/2}x\right]$$

the Hamiltonian has the form

$$H = (a_+a_- + a_-a_+)\frac{\hbar\omega}{2}$$

[6 marks]

(**ii**) Show that

$$[a_-, a_+] = 1$$

[5 marks]

(**iii**) Prove the commutation relations

$$[H, a_\pm] = \pm\hbar\omega a_\pm$$

[5 marks]

(**iv**) Explain how to use these results to generate all the states of the harmonic oscillator.

[3 marks]

(**b**) (**i**) Write down the defining property of unitary operators and explain the importance of such operators in quantum mechanics. [3 marks]

(**ii**) Show that the eigenvalues of any operator are invariant under a unitary transformation. [3 marks]

Question 6

(**a**) (**i**) Show that the wave function of a system of identical particles must be either symmetric or anti-symmetric under interchange of any two of the particles. [5 marks]

(**ii**) Use the Slater-determinant form of the wave function of a system of fermions to demonstrate the Pauli exclusion principle and to show that the wave function is anti-symmetric under the interchange of two of the particles. [4 marks]

(**b**) Two identical non-interacting particles are in a box of dimension L with walls at $x = 0$ and $x = L$. Hence the single-particle states and their energies are respectively

$$\psi_{n_i}(x_i) = \sqrt{\frac{2}{L}} \sin \frac{n_i \pi x_i}{L}, \quad \text{with} \quad E_{n_i} = \frac{\pi^2 \hbar^2 n_i^2}{2mL^2}$$

(**i**) Obtain the first-excited state energy and eigenfunction of the system if the particles are bosons [5 marks]

(**ii**) Obtain the first-excited state energy and eigenfunction of the system if the particles are fermions [6 marks]

(**c**) The momentum-space eigenfunction $\Phi(p_x)$ of a system is related to its coordinate-space eigenfunction $\Psi(x)$ by

$$\Phi(p_x) = (2\pi\hbar)^{-1/2} \int_{-\infty}^{\infty} e^{-ip_x x/\hbar} \Psi(x) dx$$

(**i**) What is the interpretation of $|\Phi(p_x)|^2 \, dp_x$? [2 marks]

(**ii**) Obtain the momentum-space wave function corresponding to the coordinate-space wavé function.

$$\Psi(x) = \begin{cases} Ae^{-ax}, & x \geq 0 \\ 0, & x < 0 \end{cases},$$

[3 marks]

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