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KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATION, 2023/2024 ACADEMIC YEAR
FIRST YEAR, SECOND SEMESTER EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE
KMA 105 - DISCRETE MATHEMATICS

Date: 14th August, 2023

Time: 8.30am – 10.30am

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS

QUESTION ONE (30 MARKS)

- a) Using logical equivalence laws show that $(p \wedge (\neg p \wedge q)) \Leftrightarrow \sim p \wedge \sim q$ (4 Marks)
- b) Prove that $\sqrt{3}$ is irrational by contradiction (5 Marks)
- c) List the members of these sets
- i) $\{x \mid x \text{ is a sexy prime}\}$
- ii) $\{x \mid x \text{ is a real number such that } x^2=1\}$ (4 Marks)
- d) Write the inverse, converse and contrapositive of the given statement "If Kenya can qualify for AFCON, then Kenya can finish third in the competition" (4 Marks)
- e) Suppose that A is the set of sophomores at your school and B is the set of students in discrete mathematics at your school. Express each of these sets in terms of A and B .
- i) the set of sophomores taking discrete mathematics in your school (1 Mark)
- ii) the set of sophomores at your school who are not taking discrete mathematics (1 Mark)
- iii) the set of students at your school who either are sophomores or are taking discrete mathematics (1 Mark)
- iv) the set of students at your school who either are not sophomores or are not taking discrete mathematics (1 Marks)
- f) Name the following laws of arithmetic
- i) $(x+y)+z=x+(y+z)$ (1 Mark)
- ii) $xy=yx$ (1 Mark)
- iii) $x(y+z)=xy+xz$ (1 Mark)
- g) Using a Venn diagram illustrate that $A \cup (A \cap B) = A$ (3 Marks)

QUESTION TWO (20 MARKS)

- a) Distinguish between a tautology and a contradiction. (2 Marks)
- b) Test the validity of the following argument.
$$p \vee qp \longrightarrow rq \longrightarrow r \quad \therefore r$$
 (6 Marks)
- c) Given that $f(x)=2x$, $g(x)=x^2$ and $h(x)=x+1$, find:
- i) $f \circ (g \circ h)$
- ii) $g \circ (f \circ h)$ (4 Marks)

- d) A survey on a sample of 25 new cars being sold at a local auto dealer was conducted to see which of three popular options, air-conditioning (A), radio (R), and power windows (W), were already installed. The survey found: 15 had air-conditioning (A), 5 had A and W , 12 had radio (R), 9 had A and R , 3 had all three options. 11 had power windows (W), 4 had R and W . Represent this information in a well labelled Venn diagram and hence find the number of cars that had:
- Only W
 - R and W but not A
 - Only one of the options
 - None of the options
- (8 Marks)

QUESTION THREE (20 MARKS)

- Write the converse, inverse and contrapositive of the following statement “If someone has read ‘No longer at ease,’ then he remembers the character of Obi” (6 Marks)
- Let $f: R \rightarrow R$ be defined by $f(x) = 2x - 3$. Find f^{-1} (4 Marks)
- Disapprove by counter example that “for all prime numbers p , $2p + 1$ is prime (3 Marks)
- Prove by mathematical induction that $\frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \dots + \frac{1}{n(n+1)} = \frac{n}{n+1}$ (7 Marks)

QUESTION FOUR (20 MARKS)

- Using a Venn diagram to show that $\overline{A \cup B} = \overline{A} \cap \overline{B}$, if A and B are sets. (4 Marks)
- Use mathematical induction to prove that $1 + 2 + 2^2 + 2^3 + \dots + 2^n = 2^{n+1} - 1$ (4 Marks)
- Let $f: R \rightarrow R$ and $g: R \rightarrow R$ be defined by $f(x) = 7x + 1$ and $g(x) = -2$. Find the formula for the composition functions $g \circ f$, $f \circ g$ and $f \circ f$ (6 Marks)
- Prove that \sqrt{p} is irrational by contradiction. (6 Marks)

QUESTION FIVE (20 MARKS)

- Let p and q be the propositions; p : I played in AFCON for the first time.
 q : I won the AFCON.
Express proposition $\neg p \vee (p \wedge q)$ as an English sentence. (3 Marks)
- Use mathematical induction to prove that $12^n - 1$ is divisible by 11, $\forall n \in N$. (7 Marks)
- Find the number of integers between 1 and 100 inclusively that are divisible by either 5 or 7 (5 Marks)
- Let p and q denote: “I bet for the first time today”, and “I win the 1 million jackpot” respectively. State the verbal translation of each of the following;
 - $p \wedge q$
 - $\neg p \vee q$
 - $\neg p \wedge \neg q$
 - $\neg(p \vee \neg q)$
 - $\neg(\neg p \vee \neg q)$

(5 Marks)