BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

COMPUTER SCIENCE DEPARTMENT

BSc HONORS INFORMATION TECHNOLOGY/COMPUTER SCIENCE/SOFTWARE ENGINEERING/NETWORKING ENGINEERING

DISCRETE MATHEMATICS -CS205/CSH105/NWE107/SWE117

2 HOURS 30 MINUTES

APR 2025

INSTRUCTION TO CANDIDATES

This paper consists of **five (5)** questions. Answer **ALL.**

Marks are indicated in brackets at the end of each question. Total marks are 100

Question 1

a) If two families A and B receive a visitor every 32 and 27 weeks respectively, calculate,

i. the number of weeks it will take for them to receive a visitor at the same time. **[3]**

ii. the number of visitors received by each family. **[4]**

b) Using proof by:

i. mathematical induction method, prove that $4^n - 1$ is divisible by 3 for each integer greater than zero. [7]

ii. counter example that if $a > b$ then $a^2 > b^2$. [3]

iii. contradiction that "for all integers n, if n^3 is even then n is even". [3]

Question 2

a) In a group of college students, 65 play football, 45 play hockey and 42 play cricket, 20 play football and hockey, 25 play football and cricket, 15 play hockey and cricket and 8 play all the three games.

i. Represent this information on a Venn diagram. **[5]**

ii. Three students in this group are selected at random, calculate the probability that they all play the same game. **[3]**

iii. If three students from this group are selected at random, find the probability that they play all the games. **[3]**

b) Solve for the recurrence relation: $a_n = 11a_{n-1} - 28a_{n-2}$, $n \geq 2$, with $a_0 = 1$ and $a_1 = 10$. [5]

c) What is the solution to the recurrence relation $a_n = 24a_{n-1} - 144a_{n-2}$ with initial conditions $a_0 = 1$, $a_1 = 36$? [3]

d) What is the meaning of a tautology? [1]

Question 3

a) Given the two tree traversal methods in figure 1.1 below.

Pre-order: $, %, 40, 55, &, 80, 95

In-order: 40, %, 55, $, 80, &, 95

Figure 1.1 Traversal methods

i. Draw the binary tree using the above output data. [4]

ii. Hence write the output if your tree is traversed in post-order traversal. [3]

iii. Explain **three** applications of a tree data structure. [6]

b) Three digital sensors, A, B and C are used to monitor a process. The outputs from the sensors are used as the inputs to a logic circuit. A signal, X, is output from the logic circuit. Output, X, has a value of 1if either of the following two conditions occur:

- Sensor A outputs the value 1 OR sensor B outputs the value 0.
- Sensor B outputs the value 1 AND sensor C outputs the value 0.

Draw the truth table for the process described above. [7]

Question 4

a) A new business is personal computers. They predict that they will sell 20 computers in their first month, 23 in the second month, 26 in the third and so on, in arithmetic sequence.

i. How many personal computers will the company sell on the 8^{th} month? [3]

ii. How many months will pass before the company expects to sell their thousandth computer? [5]

b) A car originally worth $34 000 loses 15% of its value each year.

i. Find a geometric sequence that gives the year by year value of the car. [3]

ii. After how many years will the value of the fall below $10 000? [5]

c) Let A = {1, 2, 3, 4} and define the relation R1 as follows:
R1 = {(1,1), (1,2), (2,1) (2,2), (3,3), (4,4). Determine if R1 is reflexive and symmetric. [4]

Question 5

a) With the aid of a diagram explain the following terms as they are used in a graph data structure.

i. A weighted graph [3]

ii. A directed graph [3]

iii. An adjacency list [3]

b) Explain any **five** applications of a graph data structure showing clearly how links and nodes are represented. [10]

c) What is the meaning of a proposition? [1]

**********GOOD LUCK**********