Group Assignment

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CSE - AIML - B

Part - A :

Module - 1 : Number system and Bitwise operations.

Applications :

* Binary used in all modern computers, 1's and 0's represent ON/OFF states in circuits.
* Octal & Hexadecimal used as short hand for binary in programming and Hardware.
  Ex : Memory addresses, color codes in web design.
* Decimal standard system for everday counting and arithmetic.
* Used in digital clocks, calculators and digital meters for easy conversion between human-readable numbers and machine format.
* Important for programming languages, alogrithms and logical gates.
* Helps in reducing errors when reading..

Module - 2 : Signed, Unsigned and floating point Representations

Applications:

* Computer Arithmetic and calculations:

- Signed and Unsigned numbers are used in arithmetic operations lice addition, subtraction, multiplication and division in digital systems.

* Memory and Data storage:

- Unsigned representation is often used for memory address and sizes since these values are always non-negative.
- Signed representation is used to store both positive and negative integers.

* ~~Sig~~ Scientific and Engineering computations.

- Floating-point representation is essential for representing very large and very small numbers accurately.

Ex: In physics simulations, 3D graphics and engineering calculations.

* programming and Algorithm Design

- Different data types (int, unsigned int, float, double) are choosen based on the nature of values to be processed in software applications.

* Digital Signal processing (DSP)
- Signed numbers are used to represent audio, image and sensor signals that have both positive and negative amplitudes.

Module-3 : Modular Mathematics

Applications:

* Cryptograph (Data Science):
- Modular arithmetic is the foundation of modern encryption systems like RSA, Diffie-Hellman and Elliptic curve cryptography (ECC)
- It helps secure online communications, banking and digital signatures.

* Clock Arithmetic (Time calculations)
- Time keeping directly uses modular arithmetic
  For Example, in a 12-hour clock,
  17 hours = 5 (mod 12) -> Means 5 o'clock

* Error Detection and correction
- Used in checksums, ISBN and credit card numbers to detect input or transmission errors.

- Example : The ISBN-'10' check digit uses mod 11 arithmetic to verify the validity of book numbers.

* Computer Graphics :

- Used for cyclic color patterns, pixel wrapping and periodic image effects.
- For instance, (x + offset) % width is used to wrap pixel positions on screen.

* Gaming Algorithms :

- Modular arithmetic determines cycles in games, such as turns, scoring system or wrap-around movements on girds or maps.

Part - B :

1) A digital circuit stores a number in binary form as 1011101_2 : convert this number into octal, decimal and hexadecimal forms. Then add the hexadecimal value of $2A_{16}$ to the decimal result and express the final sum in binary form.

* Binary to Decimal

$1011101_2 = (1\times64)+(0\times32)+(1\times16)+(1\times8)+(1\times4)+$
$(0\times2)+(1\times1)$

$= 64+16+8+4+1 \Rightarrow 93_{10}$

* Binary to Octal

Group bits in 3s from right : 01011101

$= 135_8 = 135_8$

* Binary to hexadecimal

Group bits in 4s from right : 0101 1101

$= 5D_{16}$

* Add Hexadecimal $2A_{16}$ (which is 42_{10})

$93+42 = 135_{10}$

* Converting final Result to Binary.

2) Given two numbers $A = 12$ and $B = 25$

find a) $A \& B$

b) $A | B$

c) $A ^\wedge B$

$A = 1100$, $B = 11001$

a) $A \& B = 8$

b) $A | B = 29$

c) $A ^\wedge B = 21$

3) Find the Greatest Common divisor (GCD) of 60 and 75.

Factors of 60 = 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 and 60

Factors of 75 = 1, 3, 5, 15, 25, 75.

Common Factors = 1, 3, 5, 15

$\therefore$ GCD of 60 and 75 is 15

4) A spaceship transmits a signal to Earth every 38 hours. If the first signal is received at monday 6:00 Am, what day and time will the 10^{th} Signal be received?

* Each Signal interval = 38 hours

$38 \bmod 24 = 14$ → Every new signal is 14 hours a head of the last day's same time.

* We need the time after 10 signals:

10 signals → 9 intervals between them (since first signal is at start)

Total time = $9 \times 38 = 342$ hours.

* Find total days and remainder hours:

$342 \div 24 = 14$ days and 6 hours remainder so, the 10th signal is after 14 days 6 hours.

* Find day of week:

$14 \bmod 7 = 0$ → same weekday

So, day remains monday

* Add remaining 6 hours

6:00 AM + 6 hours = 12:00 pm (noon)

∴ 10th signal → Monday 12:00 pm (noon) after two weeks.

5) A computer system uses 8-bit signed integers (two's complement)

Perform the following operations and show all steps:

1) Represent -45 and +27 in 8-bit binary
2) Add the two numbers using binary addition
3) Interpret the final binary result in decimal and check for overflow.

Represent +27.

Decimal 27 → Binary (8-bit)

27 ÷ 2 = 13 r 1

13 ÷ 2 = 6 r 1

6 ÷ 2 = 3 r 0

3 ÷ 2 = 1 r 1

1 ÷ 2 = 0 r 1

Binary = 000 11011

+27 = 000 11011

Represent -45

Find binary of +45 → 00101101

Take two's complement to get -45:

invert : 11010010

Add 1 → 11010011

$-45 = 11010011$

$$\begin{array}{r} 11010011 \\ 0001101 \\ \hline 1110110 \end{array}$$

* 1110110 → MSB = 1 → negative number

take two's complement to ~~final~~ find magnitude

invert → 0001000 1

Add 1 → 00010010 = 18

Result = 18

∴ −45+27 = −18

Binary : 11101110.