Subject Name Solutions

4331105 – Winter 2023

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

Define algorithm and write an algorithm to find area of circle.

Solution

An algorithm is a step-by-step procedure or set of rules for solving a specific problem or accomplishing a particular task.

Algorithm to find area of circle:

```
Step 1: Start
Step 2: Input radius (r) of the circle
Step 3: Calculate area =   \times r^{2}
Step 4: Display the area
Step 5: Stop
```

Mnemonic

"Start, Read, Calculate, Display, Stop"

Question 1(b) [4 marks]

Define flowchart and draw a flowchart to find minimum of three numbers.

Solution

A flowchart is a visual representation of an algorithm using standardized symbols and shapes connected by arrows to show the sequence of steps.

Flowchart to find minimum of three numbers:

```
flowchart LR
    A([Start]) {-{-} B[/Input three numbers A, B, C/]}
    B {-{-} C\{Is A  B?\}}
    C {-{-}|Yes| D\{Is A  C?\}}
    C {-{-}|No| E\{Is B  C?\}}
    D {-{-}|Yes| F[min = A]}
    D {-{-}|No| G[min = C]}
    E {-{-}|Yes| H[min = B]}
    E {-{-}|No| I[min = C]}
    F {-{-} J[/Display min/]}
    G {-{-} J}
    H {-{-} J}
    I {-{-} J}
    J {-{-} K([Stop])}
```

- **Comparison Strategy**: First compare A and B, then compare with C
- **Branching Logic**: Use if-else structure to find smallest value

Mnemonic

"Compare pairs, find the rare small value everywhere"

Question 1(c) [7 marks]

I=PRN/100 Where
P=Principle amount,
R=Rate of interest and
N=Period.**Write a program to calculate simple interest using below equation.**
I=PRN/100 Where
P=Principle amount,
R=Rate of interest and
N=Period.

Solution

```
\#include {stdio.h}

int main() \{
    float P, R, N, I;

    // Input principal amount, rate of interest and time period
    printf("Enter Principal amount: ");
    scanf("\%f", \&P);

    printf("Enter Rate of interest: ");
    scanf("\%f", \&R);

    printf("Enter Time period (in years): ");
    scanf("\%f", \&N);

    // Calculate Simple Interest
    I = (P * R * N) / 100;

    // Display the result
    printf("Simple Interest = \%.2f{n}", I);

    return 0;
\}
```

Diagram:

```
flowchart LR
    P["Principal (P)"] {-{-} Formula["I = (P  R  N) / 100"]}
    R["Rate (R)"] {-{-} Formula}
    N["Period (N)"] {-{-} Formula}
    Formula {-{-} Interest["Interest (I)"]}
```

- **Floating-point variables: Store decimal values for precision**
- **User interaction: Clear prompts for input**
- **Result formatting: %.2f displays two decimal places**

Mnemonic

“Principal, Rate and Number, divided by Hundred gives Interest”

Question 1(c OR) [7 marks]

Write a program to read radius(R) and height(H) from keyboard and print calculated the volume(V) of cylinder using V= R$^2 H$

Solution

```
\#include {stdio.h}

int main() \{
    float radius, height, volume;
    const float PI = 3.14159;

    // Input radius and height
    printf("Enter radius of cylinder: ");
    scanf("\%f", \&radius);

    printf("Enter height of cylinder: ");
    scanf("\%f", \&height);

    // Calculate volume of cylinder
    volume = PI * radius * radius * height;

    // Display the result
    printf("Volume of cylinder = \%.2f{n}", volume);

    return 0;
\}
```

Diagram:

```
flowchart LR
    A[/Input radius, height/] {-{-} B["Calculate volume =   radius^{2}  height"]}
    B {-{-} C[/Display volume/]}
```

- **Constants:** PI defined as constant for clarity
- **Formula:** Use R$^{2}bymultiplyingradiustwice$
- **Input validation:** Assumes positive values for radius and height

Mnemonic

"Radius squared times height times Pi, gives cylinder volume, don't ask why"

Question 2(a) [3 marks]

List out different operators supported in C programming language.

Solution

Category	Operators
Arithmetic	+, -, *, /, % (addition, subtraction, multiplication, division, modulus)
Relational	==, !=, >, <, >=, <= (equal, not equal, greater than, less than, greater than or equal to, less than or equal to)
Logical	&&, ||, ! (AND, OR, NOT)
Assignment	=, +=, -=, *=, /=, %= (assign, plus-assign, minus-assign, etc.)
Increment/Decrement	++, – (increment, decrement)
Bitwise	&, |, ˆ, ~, «, » (AND, OR, XOR, complement, left shift, right shift)
Conditional	? : (ternary operator)
Special	sizeof(), &, *, ->, . (size, address, pointer, structure)

Mnemonic

"ARABIA CS" (Arithmetic, Relational, Assignment, Bitwise, Increment, Assignment, Conditional, Special)

Question 2(b) [4 marks]

Explain Relational operator and Increment/Decrement operator with example.

Solution

Operator Type	Description	Example	Output
Relational	Compare two values to test the relationship between them	`int a = 5, b = 10;printf("%d", a < b);`	`1` (true)
	Equal to (==)	`printf("%d", 5 == 5);`	`1` (true)
	Not equal to (!=)	`printf("%d", 5 != 10);`	`1` (true)
	Greater/Less than	`printf("%d %d", 5 > 3, 5 < 3);`	`1 0`
Increment	Increases value by 1Pre-increment (++x): increment then usePost-increment (x++): use then increment	`int x = 5;printf("%d ", ++x);printf("%d", x);`	`6 6`
Decrement	Decreases value by 1Pre-decrement (–x): decrement then usePost-decrement (x–): use then decrement	`int y = 5;printf("%d ", y--);printf("%d", y);`	`5 4`

- Relational operators: Return 1 (true) or 0 (false)
- Increment/Decrement: Changes variable value and returns a value

Mnemonic

"Relational tells if TRUE or LIE, Increment/Decrement makes values rise or DIE"

Question 2(c) [7 marks]

Write a program to print sum and average of 1 to 100.

Solution

```
\#include {stdio.h}

int main() \{
    int i, sum = 0;
    float average;

    // Calculate sum of numbers from 1 to 100
    for(i = 1; i {=} 100; i++) \{
        sum += i;
    \}

    // Calculate average
    average = (float)sum / 100;
    // Display the results
    printf("Sum of numbers from 1 to 100 = \%d{n}", sum);
    printf("Average of numbers from 1 to 100 = \%.2f{n}", average);

    return 0;
\}
```

Diagram:

```
flowchart LR
    A([Start]) {-{-} B[Initialize sum = 0]}
    B {-{-} C[Set i = 1]}
    C {-{-} D\{Is i = 100?\}}
    D {-{-}|Yes| E[sum = sum + i]}
    E {-{-} F[i = i + 1]}
    F {-{-} D}
    D {-{-}|No| G[Calculate average = sum / 100]}
    G {-{-} H[Display sum and average]}
    H {-{-} I([Stop])}
```

- **Loop counter: Variable i tracks numbers 1 to 100**
- **Sum calculation: Accumulates values in sum variable**
- **Type casting: (float) converts sum to floating-point for accurate division**

Mnemonic

"Sum One to Hundred, then Divide for Average"

Question 2(a OR) [3 marks]

State the difference between gets(S) and scanf("%s",S) where S is string.

Solution

Feature	gets(S)	scanf("%s",S)
Input termination	Reads until newline character ()	Reads until whitespace (space, tab, newline)
Whitespace handling	Can read string with spaces	Stops reading at first whitespace
Buffer overflow	No bounds checking (unsafe)	No bounds checking (unsafe)
Return value	Returns S on success, NULL on error	Returns number of items successfully read
Replacement	fgets() is safer alternative	scanf("%ns",S) with width limit is safer

- **Safety concern: Both functions can cause buffer overflow**
- **Practical usage: gets() for full lines, scanf() for single words**

Mnemonic

"gets Gets Everything Till newline, scanf Stops Catching After Finding whitespace"

Question 2(b OR) [4 marks]

Explain Logical operator and Assignment operator with example.

Solution

Operator Type	Description	Example	Output
Logical	Perform logical operations on conditions	`int a = 5, b = 10;`	
	Logical AND (&&)	`printf("%d", (a > 0) && (b > 0));`	1 (true)
	Logical OR (\	\	)
	Logical NOT (!)	`printf("%d", !(a == b));`	1 (true)
Assignment	Assign values to variables	`int x = 10;`	`x = 10`
	Simple assignment (=)	`x = 20;`	`x = 20`
	Add and assign (+=)	`x += 5;`	`x = 25`
	Subtract and assign (-=)	`x -= 10;`	`x = 15`
	Multiply and assign (*=)	`x *= 2;`	`x = 30`
	Divide and assign (/=)	`x /= 3;`	`x = 10`

- **Logical operators:** Used in decision making
- **Short-circuit evaluation:** && and || evaluate only what's necessary
- **Compound assignment:** Combines operation and assignment

Mnemonic

"AND needs all TRUE, OR needs just one; Assignment takes right, puts it on the left throne"

Question 2(c OR) [7 marks]

Write a program to print all the integers between given two floating point numbers.

Solution

```
\#include {stdio.h}
\#include {math.h}

int main() \{
    float num1, num2;
    int start, end, i;

    // Input two floating point numbers
    printf("Enter first floating point number: ");
    scanf("\%f", \&num1);

    printf("Enter second floating point number: ");
    scanf("\%f", \&num2);

    // Find the ceil of smaller number and floor of larger number
    if(num1 {} num2) \{
        start = ceil(num1);
        end = floor(num2);
    \} else \{
        start = ceil(num2);
        end = floor(num1);
    \}

    // Print all integers between the two numbers
    printf("Integers between \%.2f and \%.2f are:{n}", num1, num2);
    for(i = start; i {=} end; i++) \{
        printf("\%d ", i);
    \}
    printf("{n}");

    return 0;
\}
```

Diagram:

```
flowchart LR
    A[/num1, num2     /] {-{-} B\{  num1  num2?\}}
    B {-{-}| | C["start = ceil(num1)br /end = floor(num2)"]}
    B {-{-}| | D["start = ceil(num2)br /end = floor(num1)"]}
    C {-{-} E[start   end              ]}
    D {-{-} E}
```

- **Math functions: ceil() rounds up, floor() rounds down**
- **Range determination: Works regardless of input order**
- **Integer extraction: Only prints whole numbers between floats**

Mnemonic

"Ceiling the small, flooring the big, then print every Integer in between"

Question 3(a) [3 marks]

Explain multiple if-else statement with example.

Solution

Multiple if-else statements allow testing several conditions in sequence, where each condition is checked only if the previous conditions are false.

```
\#include {stdio.h}

int main() \{
    int marks;

    printf("Enter marks (0{-100): "});
    scanf("\%d", \&marks);

    if(marks {=} 80) \{
        printf("Grade: A{n}");
    \} else if(marks {=} 70) \{
        printf("Grade: B{n}");
    \} else if(marks {=} 60) \{
        printf("Grade: C{n}");
    \} else if(marks {=} 50) \{
        printf("Grade: D{n}");
    \} else \{
        printf("Grade: F{n}");
    \}

    return 0;
\}
```

Diagram:

```
flowchart LR
    A[/Input marks/] {-{-} B\{marks = 80?\}}
    B {-{-}|Yes| C[Grade: A]}
    B {-{-}|No| D\{marks = 70?\}}
    D {-{-}|Yes| E[Grade: B]}
    D {-{-}|No| F\{marks = 60?\}}
    F {-{-}|Yes| G[Grade: C]}
    F {-{-}|No| H\{marks = 50?\}}
    H {-{-}|Yes| I[Grade: D]}
    H {-{-}|No| J[Grade: F]}
```

- Sequential testing: Only one block executes
- Efficiency: Stops checking after finding true condition

Mnemonic

"If this THEN that, ELSE IF another THEN something else"

Question 3(b) [4 marks]

State the working of while loop and for loop.

Solution

Loop Type	Working	Syntax	Use Cases
while loop	1. Test condition2. If true, execute body3. Repeat steps 1-2 until condition is false	`while(condition) {// statements}`	When number of iterations is unknown beforehand
for loop	1. Execute initialization once2. Test condition3. If true, execute body4. Execute update statement5. Repeat steps 2-4 until condition is false	`for(initialization; condition; update) {// statements}`	When number of iterations is known beforehand

Comparison:

```
flowchart TD
    subgraph "while loop"
    A1[Start] {-{-} B1\{Conditionbr /True?\}}
    B1 {-{-}|Yes| C1[Executebr /Body]}
    C1 {-{-} B1}
    B1 {-{-}|No| D1[End]}
    end

    subgraph "for loop"
    A2[Initialization] {-{-} B2\{Conditionbr /True?\}}
    B2 {-{-}|Yes| C2[Executebr /Body]}
    C2 {-{-} D2[Update]}
    D2 {-{-} B2}
    B2 {-{-}|No| E2[End]}
    end
```

- Entry control: Both check condition before execution
- Components: for loop combines initialization, condition, and update

Mnemonic

"WHILE checks THEN acts, FOR initializes CHECKS acts UPDATES"

Question 3(c) [7 marks]

Write a program to find factorial of a given number.

Solution

```
\#include {stdio.h}

int main() \{
    int num, i;
    unsigned long long factorial = 1;

    // Input a number
    printf("Enter a positive integer: ");
    scanf("\%d", \&num);

    // Check if the number is negative
    if(num {} 0) \{
        printf("Error: Factorial is not defined for negative numbers.{n}");
    \} else \{
        // Calculate factorial
        for(i = 1; i {=} num; i++) \{
            factorial *= i;
        \}

        printf("Factorial of \%d = \%llu{n}", num, factorial);
    \}

    return 0;
\}
```

Diagram:

```
flowchart LR
    A([Start]) {-{-} B[/Input number/]}
    B {-{-} C\{Is number  0?\}}
    C {-{-}|Yes| D[/Display error message/]}
    C {-{-}|No| E[Initialize factorial = 1]}
    E {-{-} F[Set i = 1]}
    F {-{-} G\{Is i = number?\}}
    G {-{-}|Yes| H[factorial = factorial * i]}
    H {-{-} I[i = i + 1]}
    I {-{-} G}
    G {-{-}|No| J[/Display factorial/]}
    D {-{-} K([Stop])}
    J {-{-} K}
```

- **Data type: unsigned long long for large factorials**
- **Error handling: Checks for negative input**
- **Loop implementation: Multiply successive integers**

Mnemonic

"Factorial Formula: Multiply From One to Number"

Question 3(a OR) [3 marks]

Explain the working of switch-case statement with example.

Solution

The switch-case statement is a multi-way decision maker that tests the value of an expression against various case values and executes the matching case block.

```
\#include {stdio.h}

int main() \{
    int day;

    printf("Enter day number (1{-7): "});
    scanf("\%d", \&day);

    switch(day) \{
        case 1:
            printf("Monday{n}");
            break;
        case 2:
            printf("Tuesday{n}");
            break;
        case 3:
            printf("Wednesday{n}");
            break;
        case 4:
            printf("Thursday{n}");
            break;
        case 5:
            printf("Friday{n}");
            break;
        case 6:
            printf("Saturday{n}");
            break;
        case 7:
            printf("Sunday{n}");
            break;
        default:
            printf("Invalid day number{n}");
    \}

    return 0;
\}
```

Diagram:

```
flowchart LR
    A[/Input day/] {-{-} B\{"switch(day)"\}}
    B {-{-} C1\{case 1\}}
    B {-{-} C2\{case 2\}}
    B {-{-} C3\{...\}}
    B {-{-} C4\{case 7\}}
    B {-{-} C5\{default\}}
    C1 {-{-}|match| D1[Print {-} Monday]}
    C2 {-{-}|match| D2[Print {-} Tuesday]}
    C3 {-{-}|match| D3[...]}
    C4 {-{-}|match| D4[Print {-} Sunday]}
    C5 {-{-}|no match| D5[Print {-} Invalid day]}
    D1 {-{-} E[break]}
    D2 {-{-} E}
    D3 {-{-} E}
    D4 {-{-} E}
    D5 {-{-} F([End])}
    E {-{-} F}
```

- **Expression evaluation: Only integer or character types**

- Case matching: Executes matching case until break
- Default case: Executes when no case matches

Mnemonic

"SWITCH value, CASE match, BREAK out, DEFAULT rescue"

Question 3(b OR) [4 marks]

Define break and continue keyword.

Solution

Keyword	Definition	Purpose	Example
break	Terminates the innermost loop or switch statement immediately	To exit a loop prematurely when a certain condition is met	`c for(i=1; i<=10; i++) { if(i == 5) break; printf("%d ", i); } // Output: 1 2 3 4`
continue	Skips the rest of the current iteration and jumps to the next iteration of the loop	To skip specific iterations without terminating the loop	`c for(i=1; i<=10; i++) { if(i == 5) continue; printf("%d ", i); } // Output: 1 2 3 4 6 7 8 9 10`

Behavioral Comparison:

```
flowchart TD
    subgraph "break"
    A1[Enter Loop] {-{-} B1\{Conditionbr /for break?\}}
    B1 {-{-}|Yes| C1[Exit Loop]}
    B1 {-{-}|No| D1[Continuebr /Execution]}
    D1 {-{-} E1[Nextbr /Iteration]}
    E1 {-{-} B1}
    end

    subgraph "continue"
    A2[Enter Loop] {-{-} B2\{Conditionbr /for continue?\}}
    B2 {-{-}|Yes| C2[Skip Restbr /of Loop Body]}
    B2 {-{-}|No| D2[Continuebr /Execution]}
    C2 {-{-} E2[Nextbr /Iteration]}
    D2 {-{-} E2}
    E2 {-{-} B2}
    end
```

- Scope: Both affect only the innermost loop
- Control transfer: break exits loop, continue jumps to next iteration

Mnemonic

"BREAK leaves the room, CONTINUE skips to the next dance move"

Question 3(c OR) [7 marks]

Write a program to read number of lines (n) from keyboard and print the triangle shown below.

For Example, n=5

1

```
1 2
1 2 3
1 2 3 4
1 2 3 4 5
```

Solution

```
\#include {stdio.h}

int main() \{
    int n, i, j;

    // Input number of lines
    printf("Enter number of lines: ");
    scanf("\%d", \&n);

    // Print the triangle pattern
    for(i = 1; i {=} n; i++) \{
        // Print numbers from 1 to i in each row
        for(j = 1; j {=} i; j++) \{
            printf("\%d ", j);
        \}
        printf("{n}");
    \}

    return 0;
\}
```

Pattern Visualization:

```
Row 1: 1
Row 2: 1 2
Row 3: 1 2 3
Row 4: 1 2 3 4
Row 5: 1 2 3 4 5
```

Program Flow:

```
flowchart LR
    A[/Input n/] {-{-} B[Set i = 1]}
    B {-{-} C\{Is i = n?\}}
    C {-{-}|Yes| D[Set j = 1]}
    D {-{-} E\{Is j = i?\}}
    E {-{-}|Yes| F[/Print j/]}
    F {-{-} G[j = j + 1]}
    G {-{-} E}
    E {-{-}|No| H[/Print newline/]}
    H {-{-} I[i = i + 1]}
    I {-{-} C}
    C {-{-}|No| J([Stop])}
```

- **Nested loops: Outer loop for rows, inner loop for columns**
- **Pattern logic: Row number determines how many numbers to print**
- **Number sequence: Each row prints 1 to row number**

Mnemonic

“Rows decide COUNTer limit, COLumns print ONE to ROW”

Question 4(a) [3 marks]

Explain nested if-else statement with example.

Solution

Nested if-else statements are if-else constructs placed inside another if or else block, allowing more complex conditional logic and multiple levels of decision making.

```
\#include {stdio.h}

int main() \{
    int age;
    char hasID;

    printf("Enter age: ");
    scanf("\%d", \&age);

    printf("Do you have ID? (Y/N): ");
    scanf(" \%c", \&hasID);

    if(age {=} 18) \{
        if(hasID == {Y} || hasID == {y}) \{
            printf("You can vote!{n}");
        \} else \{
            printf("You need ID to vote.{n}");
        \}
    \} else \{
        printf("You must be 18 or older to vote.{n}");
    \}

    return 0;
\}
```

Decision Tree:

```
flowchart LR
    A[/Input age and hasID/] {-{-} B\{age = 18?\}}
    B {-{-}|Yes| C\{hasID == Ybr /or y?\}}
    C {-{-}|Yes| D[You can vote!]}
    C {-{-}|No| E[You need ID to vote]}
    B {-{-}|No| F[You must be 18 or older to vote]}
```

- **Hierarchical conditions: Evaluates conditions in layers**
- **Indentation: Improves readability of nested structures**
- **Multi-factor decisions: Combines multiple criteria**

Mnemonic

"If INSIDE if, check DEEPER conditions"

Question 4(b) [4 marks]

Describe initialization of one-dimensional array.

Solution

Initialization Method	Syntax	Example	Description
Declaration with size	`data_type array_name[size];`	`int marks[5];`	Creates array with specified size, elements have garbage values
Declaration with initialization	`data_type array_name[size] = {values};`	`int ages[4] = {21, 19, 25, 32};`	Creates and initializes array with specific values

Partial initialization	`data_type array_name[size] = {values};`	`int nums[5] = {1, 2};`	Initializes first elements, rest become zero
Size inference	`data_type array_name[] = {values};`	`int scores[] = {95, 88, 72, 84, 91};`	Size determined by number of initializers
Individual element	`array_name[index] = value;`	`marks[0] = 85;`	Assigns value to specific element

Array Visualization:

`int numbers[5] = {10, 20, 30, 40, 50};`

```
  10    20    30    40    50

  [0]    [1]    [2]    [3]    [4]    \leftarrow indices
```

- **Zero-indexing:** First element at index 0
- **Contiguous memory:** Elements stored sequentially
- **Size limitation:** Size must be known at compile time

Mnemonic

"Declare SIZE first, then FILL with values or let COMPILER COUNT"

Question 4(c) [7 marks]

Define Array and write a program to reverse a string.

Solution

An array is a collection of similar data items stored at contiguous memory locations and accessed using a common name.

```
\#include {stdio.h}
\#include {string.h}

int main() \{
    char str[100], reversed[100];
    int i, j, length;

    // Input a string
    printf("Enter a string: ");
    gets(str);

    // Find the length of string
    length = strlen(str);

    // Reverse the string
for(i = length {-} 1,

j = 0; i {=} 0; i{-{-},} j++) \{

        reversed[j] = str[i];
    \}

    // Add null terminator
    reversed[j] = {}{0}{};

    // Display the reversed string
    printf("Reversed string: \%s{n}", reversed);

    return 0;
\}
```

Algorithm Visualization:

```
flowchart LR
    A["Original: {HELLO"] {-}{-} B["H"] \& C["E"] \& D["L"] \& E["L"] \& F["O"]}
    F {-{-} G["reversed[0]"]}
    E {-{-} H["reversed[1]"]}
    D {-{-} I["reversed[2]"]}
    C {-{-} J["reversed[3]"]}
    B {-{-} K["reversed[4]"]}
    G \& H \& I \& J \& K {-{-} L["Reversed: OLLEH"]}
```

- **Character array: Stores string with null terminator**
- **Two-pointer technique: One for original, one for reversed**
- **Zero-based indexing: Arrays start at index 0**

Mnemonic

“Start from END, place at BEGIN, stop at ZERO”

Question 4(a OR) [3 marks]

Explain do while loop with example

Solution

The do-while loop is an exit-controlled loop that executes the loop body at least once before checking the condition.

```
\#include {stdio.h}

int main() \{
    int num, sum = 0;

    do \{
        printf("Enter a number (0 to stop): ");
        scanf("\%d", \&num);
        sum += num;
    \} while(num != 0);

    printf("Sum of all entered numbers: \%d{n}", sum);

    return 0;
\}
```

Loop Execution Flow:

```
flowchart LR
    A([Start]) {-{-} B[sum = 0]}
    B {-{-} C[/Input num/]}
    C {-{-} D[sum = sum + num]}
    D {-{-} E\{Is num != 0?\}}
    E {-{-}|Yes| C}
    E {-{-}|No| F[/Display sum/]}
    F {-{-} G([Stop])}
```

Key Characteristics:

- **Execution order: Body first, condition check later**
- **Guaranteed execution: Loop body always executes at least once**
- **Termination: Condition evaluated at bottom of loop**

Mnemonic

"DO first, ask questions WHILE later"

Question 4(b OR) [4 marks]

Define pointer and describe pointer with example.

Solution

A pointer is a variable that stores the memory address of another variable.

Pointer Concept	Description	Example
Declaration	Data_type *pointer_name;	`int *ptr;`
Initialization	Assign address of a variable	`int num = 10; int *ptr = &num;`
Dereference	Access the value at the address	`printf("%d", *ptr);` // Prints 10
Address operator	Gets address of a variable	`printf("%p", &num);` // Prints address
Null pointer	Pointer that points to nothing	`int *ptr = NULL;`

Pointer Visualization:

```
Memory:

 \&num   1000        \&ptr   2000

 num      10        ptr    1000


                         { Points to address of num}
```

- Indirect access: Access variables through their addresses
- Memory manipulation: Direct memory access for efficiency
- Dynamic memory: Enables allocation/deallocation during runtime

Mnemonic

"Pointers POINT to ADDRESS, STARS dereference to VALUES"

Question 4(c OR) [7 marks]

Define pointer and write a program to exchange two integers using pointer arguments.

Solution

A pointer is a variable that contains the memory address of another variable, allowing indirect access and manipulation of data.

```
\#include {stdio.h}

// Function to swap two integers using pointers
void swap(int *a, int *b) \{
    int temp = *a;
    *a = *b;
    *b = temp;
\}

int main() \{
    int num1, num2;
    // Input two integers
    printf("Enter first number: ");
    scanf("\%d", \&num1);

    printf("Enter second number: ");
    scanf("\%d", \&num2);

    printf("Before swapping: num1 = \%d, num2 = \%d{n}", num1, num2);

    // Call swap function with addresses of num1 and num2
    swap(\&num1, \&num2);

    printf("After swapping: num1 = \%d, num2 = \%d{n}", num1, num2);

    return 0;
\}
```

Swap Process Visualization:

```
flowchart LR
    A[a points to num1{br /b points to num2] {-}{-} B[temp = *a]}
    B {-{-} C[*a = *b]}
    C {-{-} D[*b = temp]}
    D {-{-} E[Values exchanged]}
```

Memory Changes:

```
Before swap:
num1 = 5, num2 = 10
a --> num1, b --> num2

Step 1: temp = *a
temp = 5, num1 = 5, num2 = 10

Step 2: *a = *b
temp = 5, num1 = 10, num2 = 10

Step 3: *b = temp
temp = 5, num1 = 10, num2 = 5

After swap:
num1 = 10, num2 = 5
```

- **Pass by reference: Pointers allow functions to modify original variables**
- **Temporary variable: Required for swapping without data loss**
- **Function parameter: Pointer arguments pass addresses**

Mnemonic

"Grab by ADDRESS, change the CONTENT, without being PRESENT"

Question 5(a) [3 marks]

Write a program to find the numbers which are divisible by 7 in between the numbers 50 and 500.

Solution

```
\#include {stdio.h}

int main() \{
    int i, count = 0;
    printf("Numbers divisible by 7 between 50 and 500:{n}");

    // Find and print numbers divisible by 7
    for(i = 50; i {=} 500; i++) \{
        if(i \% 7 == 0) \{
            printf("\%d ", i);
            count++;

            // Print 10 numbers per line for better readability
            if(count \% 10 == 0)
                printf("{n}");
        \}
    \}

    printf("{n}Total count: \%d{n}", count);

    return 0;
\}
```

Algorithm Visualization:

```
flowchart LR
A([Start]) {-{-} B[Set

i = 50, count = 0]}

    B {-{-} C\{Is i = 500?\}}
    C {-{-}|Yes| D\{Is i \% 7 == 0?\}}
    D {-{-}|Yes| E[Print ibr /count++]}
    D {-{-}|No| F[i++]}
    E {-{-} F}
    F {-{-} C}
    C {-{-}|No| G[Print total count]}
    G {-{-} H([Stop])}
```

- **Modulo operator: i % 7 == 0 checks divisibility**
- **Formatting output: Line breaks for readability**
- **Counter variable: Tracks how many numbers found**

Mnemonic

"DIVide by SEVEN, ZERO remainder wins"

Question 5(b) [4 marks]

Write a program which reads an integer from keyboard and prints whether given number is odd or even.

Solution

```
\#include {stdio.h}

int main() \{
    int number;

    // Input an integer
    printf("Enter an integer: ");
    scanf("\%d", \&number);

    // Check if the number is even or odd
    if(number \% 2 == 0) \{
        printf("\%d is an even number.{n}", number);
    \} else \{
        printf("\%d is an odd number.{n}", number);
    \}

    return 0;
\}
```

Decision Logic:

```
flowchart LR
    A[/Input number/] {-{-} B\{Is number \% 2 == 0?\}}
    B {-{-}|Yes| C[/Print "number is even"/]}
    B {-{-}|No| D[/Print "number is odd"/]}
    C {-{-} E([End])}
    D {-{-} E}
```

Modulo Division Table for Small Numbers:

Number	Number % 2	Even/Odd
0	0	Even
1	1	Odd
2	0	Even
3	1	Odd
4	0	Even

- Modulo test: Even numbers have remainder 0 when divided by 2
- Binary representation: Last bit is 0 for even, 1 for odd
- Simple algorithm: Works for all integers including negatives

Mnemonic

"EVEN with ZERO end, ODD with ONE bend"

Question 5(c) [7 marks]

Define structure? Explain how it differs from array? Develop a structure named book to save following information about books. Book title, Name of author, Price and Number of pages.

Solution

A structure is a user-defined data type that allows grouping of variables of different data types under a single name.
Difference between Structure and Array:

Feature	Structure	Array
Data type	Can store different data types	Stores elements of same data type
Access	Members accessed using dot (.) operator	Elements accessed using index []
Memory allocation	Memory may not be contiguous	Memory is always contiguous
Size	Size can vary for each member	Size is same for all elements
Declaration	Uses struct keyword	Uses square brackets []
Purpose	Organizes related heterogeneous data	Organizes homogeneous data

Book Structure Program:

```
\#include {stdio.h}
\#include {string.h}

// Define the structure
struct Book \{
    char title[100];
    char author[50];
    float price;
    int pages;
\;}

int main() \{
    // Declare a variable of type struct Book
    struct Book myBook;

    // Assign values to the structure members
    strcpy(myBook.title, "C Programming");
    strcpy(myBook.author, "Dennis Ritchie");
    myBook.price = 350.50;
    myBook.pages = 285;

    // Display book information
    printf("Book Details:{n}");
    printf("Title: \%s{n}", myBook.title);
    printf("Author: \%s{n}", myBook.author);
    printf("Price: \%.2f{n}", myBook.price);
    printf("Pages: \%d{n}", myBook.pages);

    return 0;
\}
```

Structure Visualization:

`struct Book myBook`

Member	Value
title	"C Programming"
author	"Dennis Ritchie"
price	350.50
pages	285

- **Structure definition: Creates template for data**
- **Member access: Use dot operator (structure.member)**
- **String handling: Uses string functions for character arrays**

Mnemonic

"STRUCTURE groups DIFFERENT, ARRAY repeats SAME"

Question 5(a OR) [3 marks]

Write a program which reads a real number from keyboard and prints a smallest integer greater than it.

Solution

```
\#include {stdio.h}
\#include {math.h}

int main() \{
    float number;
    int result;

    // Input a real number
    printf("Enter a real number: ");
    scanf("\%f", \&number);

    // Find smallest integer greater than the input
    result = ceil(number);

    // Display the result
    printf("Smallest integer greater than \%.2f is \%d{n}", number, result);

    return 0;
\}
```

Function Behavior:

```
flowchart LR
    A[/Input real number/] {-{-} B[Apply ceil function]}
    B {-{-} C[/Display result/]}
```

Examples of ceil() function:

```
Real Number | ceil() Result
------------|-------------
    3.14    |      4
    5.0     |      5
   -2.7     |     -2
```

- **Math function: ceil() rounds up to next integer**
- **Result type: Returns smallest integer greater than input**
- **Handling edge cases: Works with negative numbers**

Mnemonic

"CEILING function, UP we go, NEXT integer we show"

Question 5(b OR) [4 marks]

Write a program which reads character from keyboard and prints its ASCII value.

Solution

```
\#include {stdio.h}

int main() \{
    char ch;

    // Input a character
    printf("Enter a character: ");
    scanf("\%c", \&ch);

    // Display ASCII value of the character
    printf("ASCII value of {}\%c{ is }\%d{n}", ch, ch);

    return 0;
\}
```

Program Visualization:

```
flowchart LR
    A[/Input character/] {-{-} B[/Print character and its ASCII value/]}
```

ASCII Table Sample:

```
Character | ASCII Value
----------|------------
    'A'    |     65
    'a'    |     97
    '0'    |     48
    ' '    |     32
```

- **Character storage:** Characters stored as integers in memory
- **Type conversion:** Automatic conversion from char to int
- **Extended ASCII:** Values from 0 to 255 for 8-bit characters

Mnemonic

"CHARS have NUMBERS underneath, PRINT shows BOTH sides"

Question 5(c OR) [7 marks]

Define function? Explain its advantage. Write function to calculate the square of a given integer number.

Solution

A function is a self-contained block of code designed to perform a specific task. It takes input, processes it, and returns an output.
Advantages of Functions:

Advantage	Description
Code reusability	Write once, use many times
Modularity	Break complex problems into manageable parts
Maintainability	Easier to debug and modify isolated code
Abstraction	Hide implementation details
Readability	Makes code more organized and understandable
Scope control	Variables local to functions reduce naming conflicts

Program with Square Function:

```
\#include {stdio.h}

// Function to calculate square of an integer
int square(int num) \{
    return num * num;
\}

int main() \{
    int number, result;

    // Input an integer
    printf("Enter an integer: ");
    scanf("\%d", \&number);

    // Call the square function
    result = square(number);

    // Display the result
    printf("Square of \%d is \%d{n}", number, result);

    return 0;
\}
```

Function Flow:

```
flowchart LR
    A[main function] {-{-}|call with number| B[square function]}
    B {-{-}|return num * num| C[main function]}
    C {-{-}|display result| D[End]}
```

Function Components:

```
Return Type    Function Name    Parameters
    ↓               ↓               ↓
   int           square          (int num)
                    ↓
              Function Body
            {
             return num * num;   \leftarrow Function Logic
            }
```

- **Function prototype: Declares function signature**
- **Parameters: Input values passed to function**
- **Return value: Output or result from function**

Mnemonic

"Functions ENCAPSULATE tasks, take INPUTS, give OUTPUTS"