Unit II | Algorithmic Problem Solving CHAPTER 8

Iteration and Recursion

1.Define Iteration.

- In iteration, the **loop body is repeatedly** executed as long as the loop **condition** is **true**.
- Each time the loop body is executed, the **variables** are **updated**.

2.Define Recursion

- Recursion is an algorithm design technique.
- It is similar to iteration, but more powerful.
- Using recursion, we can solve a problem with a given input,
- by solving the instances of the problem with a part of the input.

3.What is an invariant?

- An expression involving **variables**, which remains **unchanged** by an **assignment.**
- These variables are called an **invariant** of the assignment

4.Define a loop invariant.

- An invariant for the **loop body** is known as a loop invariant

5.Does testing the loop condition affect the loop invariant? Why?

No. It does not affect the loop invariant.
Because a loop invariant is true

- at the **start** of the **loop**
- at the **start** of **each iteration**
- at the **end** of **each iteration**
- at the **end** of the **loop** .

6.What is the relationship between loop invariant, loop condition and the input- output recursively?

- Establish the loop invariant at the **start** of the loop.
- The loop body should be **update** the variables and **maintain** the loop invariant, at the **same time**.
- When the loop **ends**, the termination **condition** and the **loop invariant** should establish the i**nput-output relation.**

7.What is recursive problem solving?

To solve a problem recursively,

- Each solver receives an input and **reduces** the problem to sub-problems,
- and calls another instance of the solver, known as sub-solver, to solve the sub-problem is known as **recursive call.**
- The input size to a **sub-problem** is **smaller** than the input size to the **original problem**.

From the solution to the **sub-problem**, the solver **constructs** the solution **to** the **original** problem.
a recursive solver has two cases:

Base case: The problem size is small enough to be solved directly.
Recursion step: The problem size is not small enough. **Deconstruct** the problem into a sub-problem, strictly smaller in size than the given problem.

8.Define factorial of a natural number recursively.

Factorial(n)
--input :n
--output: factorial of n
get n
f=1
i=1 -- base case
loop(i<n) true
f=f*I – recursion step
False: factorial of n

9.There are 7 tumblers on a table, all standing upside down. You are allowed to turn any 2 tumblers simultaneously in one move. Is it possible to reach a situation when all the tumblers are right side up? (Hint: The parity of the number of upside down tumblers is invariant.)

Output : To turn all tumblers up
The number of tumblers up is u;
Model
1.
Two tumblers upside up
u increments by **2**
u:=u+2
2.
Two tumblers upside down
u decrements by **2**
u:=u - 2
3.
One tumbler is upside down and another is proper
u is not changed
u is either incremented or decremented
So we can ignore of u not being changed.
Now
Invariants are **u + 2 , u – 2**

10.A knockout tournament is a series of games. Two players compete in each game; the loser is knocked out (i.e. does not play any more), the winner carries on. The winner of the tournament is the player that is left after all other players have been knocked out. Suppose there are 1234 players in a tournament. How many games are played before the tournament winner is decided?

No. of Players : p
No. of Games : g

Initially : p=1234 , g = 0

p, g := p – 1 , g + 1

Invariant is p + g

Finally Winner player is 1 , p = 1

p + g : = 1234
g =1234 - 1
g = 1233 (No.of games played = 1233)

11.King Vikramaditya has two magic swords. With one, he can cut off 19 heads of a dragon, but after that the dragon grows 13 heads. With the other sword, he can cut off 7 heads, but 22 new heads grow. If all heads are cut off, the dragon dies. If the dragon has originally 1000 heads, can it ever die? (Hint:The number of heads mod 3 is invariant.)

If the dragon has 1000 heads we start at 1000=1(mod 3) we cannot get to 0 .so the **dragon lives**.

12.Assume an 8 × 8 chessboard with the usual coloring. "Recoloring" operation changes the color of all squares of a row or a column. You can recolor re-peatedly. The goal is to attain just one black square. Show that you cannot achieve the goal. (Hint: If a row or column has b black squares, it changes by (|8 - b) - b|).

White squares W = 32
Black squares B = 32

W+ B = 64 , W – B = 0 = 0 mod 4
But the required state has 63 W 1 B
So W – B = 63 – 1 = 62 = 2 mod 4
Which is **impossible**.

13.Power can also be defined recursively as

$$a^n = \begin{cases} 1 & \text{if } n = 0 \\ a \times a^{n-1} & \text{if } n \text{ is odd} \\ a^{n/2} \times a^{n/2} & \text{if } n \text{ is even} \end{cases}$$

Construct a recursive algorithm using this definition. How many multiplications are needed to calculate a 10 ?

Power (a,n)
--inputs : n integer
--output : a^n
If(n=0) --base case
1
else if (n is odd)
a x power (a , a^{n-1}) -- recursion step
else (n is even)
a x power ($a^{n/2}$ x $a^{n/2}$) -- recursion step

Choose the correct Answer

CHAPTER - 1

1. First generation computers used
(a) Vacuum tubes (b) Transistors
(c) Integrated circuits (d) Microprocessors

2. Name the volatile memory
(a) ROM (b) PROM (c) RAM (d) EPROM

3. Identify the output device
(a) Keyboard (b) Memory (c) Monitor (d) Mouse

4. Identify the input device
(a) Printer (b) Mouse (c) Plotter (d) Projector

5. …… Output device is used for printing building plan, flex board, etc. (a) Thermal printer (b) Plotter (c) Dot matrix (d) inkjet printer

6. In ATM machines, which one of the following is used to (a) Touch Screen (b) speaker (c) Monitor (d) Printer

7. When a system restarts …… ….. Which type of booting is used. (a) Warm booting (b) Cold booting (c) Touch boot (d) Real boot.

8. Expand POST
(a) Post on self Test (b) Power on Software Test
c) Power On Self Test (d) Power on Self Text

9. Which one of the following is the main memory?
(a) ROM (b) RAM (c) Flash drive (d) Hard disk

10. Which generation of computer used IC's?
(a) First (b) Second (c) Third (d) Fourth

Answers:

1.a 2.c 3.c 4.b 5.b 6.a 7.a 8.d 9.b 10.c

CHAPTER - 2 Part - I

1. Which refers to the number of bits processed by a computer's CPU?
A) Byte B) Nibble C) Word length D) Bit

2. How many bytes does 1 Kilo Byte contain?
A) 1000 B) 8 C) 4 D) 1024

3. Expansion for ASCII
A) American School Code for Information Interchange
B) American Standard Code for Information Interchange
C) All Standard Code for Information Interchange
D) American Society Code for Information Interchange

4. 2^50 is referred as
A) Kilo B) Tera C) Peta D) Zetta

5. How many characters can be handled in Binary Coded Decimal System?
A) 64 B) 255 C) 256 D) 128

6. For 11012 what is the Hexadecimal equivalent?
A) F B) E C) D D) B

7. What is the 1's complement of 00100110?
A) 00100110 B) 11011001 C) 11010001 D) 00101001

8. Which amongst this is not an Octal number?
A) 645 B) 234 C) 876 D) 123

Answers:

1.c 2.d 3.b 4.c 5.a 6.c 7.b 8.c

Part - II

1**. Which is a basic electronic circuit which operates on one or more signals?**
(A) Boolean algebra (B) Gate (C) Fundamental gates (D) Derived gates

2. Which gate is called as the logical inverter?
(A) AND (B) OR (C) NOT (D) XNOR

3. A + A = ?
(A) A (B) O (C) 1 (D) A

4. NOR is a combination of ?
(A) NOT(OR) (B)NOT(AND) (C) NOT(NOT) (D) NOT(NOR)

5. NAND is called as …… Gate
(A) Fundamental Gate (B) Derived Gate (C) Logical Gate (D) Electronic gate

Answers:

1.b 2.c 3.a 4.a 5.b

CHAPTER - 3

1. Which of the following is said to be the brain of a computer?
(a) Input devices (b) Output devices (c) Memory device (d) Microprocessor

2. Which of the following is not the part of a microprocessor unit?
(a) ALU (b) Control unit (c) Cache memory (d) register

3. How many bits constitute a word?
(a) 8 (b) 16 (c) 32 (d) determined by the processor used.

4. Which of the following device identifies the location when address is placed in the memory address register?
(a) Locator (b) encoder (c) decoder (d) multiplexer

5. Which of the following is a CISC processor?
(a) Intel P6 (b) AMD K6 (c) Pentium III (d) Pentium IV

6. Which is the fastest memory?
(a) Hard disk (b) Main memory
(c) Cache memory (d) Blue-Ray dist

7. How many memory locations are identified by a processor with 8 bits address bus at a time?
(a) 28 (b) 1024 (c) 256 (d) 8000

8. What is the capacity of 12cm diameter DVD with single sided and single layer?
(a) 4.7 GB (b) 5.5 GB (c) 7.8GB (d) 2.2 GB

9. What is the smallest size of data represented in a CD?
(a) blocks (b) sectors (c) pits (d) tracks

10. Display devices are connected to the computer through.
(a) USB port (b) Ps/2 port (c) SCSI port (d) VGA connector

Answers:

1.d 2.c 3.d 4.c 5.c 6.c 7.c
8.a 9.c 10.d

CHAPTER - 4

1) Operating system is a
A) Application Software B) Hardware
C) System Software D) Component
2) Identify the usage of Operating Systems
A) Easy interaction between the human and computer
B) Controlling input & output Devices
C) Managing use of main memory D) All the above
3) Which of the following is not a function of an Operating System?
A) Process Management B) Memory Management
C) Security management D) Complier Environment
4) Which of the following OS is a commercially licensed Operating system?
A) Windows B) UBUNTU C) FEDORA D) REDHAT
5) Which of the following Operating systems support Mobile Devices?
A) Windows 7 B) Linux C) BOSS D) iOS
6) File Management manages
A) Files B) Folders C) Directory systems D) All the Above
7) Interactive Operating System provides
A) Graphics User Interface (GUI) B) Data Distribution
C) Security Management D) Real Time Processing
8) Android is a
A) Mobile Operating system B) Open Source
C) Developed by Google D) All the above
9) Which of the following refers to Android operating system's version?
A) JELLY BEAN B) UBUNTU C) OS/2 D) MITTIKA

Answers:

1.c 2.d 3.d 4.a 5.d 6.d 7.a
8.d 9.a

CHAPTER - 5

1. From the options given below, choose the operations managed by the operating system.
a. Memory b. Processor c. I/O devices d. all the above
2. Which is the default folder for many Windows Applications to save your file?
a. My Document b. My Pictures c. Documents and Settings d. My Computer
3. Under which of the following OS, the option Shift + Delete – permanently deletes a file or folder?
a. Windows 7 b. Windows 8 c.Windows10 d. All of the OS
4. What is the meaning of "Hibernate" in Windows XP/Windows 7?
a. Restart the Computer in safe mode
b. Restart the Computer in hibernate mode
c. Shutdown the Computer terminating all the running applications
d. Shutdown the Computer without closing the running applications
5. Which of the following OS is not based on Linux?
a. Ubuntu b. Redhat c. CentOs d. BSD
6. Which of the following in Ubuntu OS is used to view the options for the devices installed?
a. Settings b. Files c. Dash d. VBox_GAs_5.2.2
7. Identify the default email client in Ubuntu.
a. Thunderbird b. Firefox c. Internet Explorer d. Chrome
8. Which is the default application for spreadsheets in Ubuntu? This is available in the software launcher.
a. LibreOffice Writer b. LibreOffice Calc
c. LibreOffice Impress d. LibreOffice Spreadsheet
9. Which is the default browser for Ubuntu?
a. Firefox b. Internet Explorer c. Chrome d. Thunderbird
10. Where will you select the option to log out, suspend, restart, or shut down from the desktop of Ubuntu OS?
a. Session Indicator b. Launcher c. Files d. Search

Answers:

1.d 2.a 3.d 4.d 5.d 6.a 7.a
8.b 9.a 10.a

CHAPTER - 6

1.Which of the following activities is algorithmic in nature?
(a) Assemble a bicycle. (b) Describe a bicycle.
(c) Label the parts of a bicycle. (d) Explain how a bicycle works.
2. Which of the following activities is not algorithmic in nature?
(a) Multiply two numbers. (b) Draw a kolam.
(c) Walk in the park. (d) Braid the hair.
3. Omitting details inessential to the task and representing only the essential features of the task is known as
(a) specification (b) abstraction
(c) composition (d) decomposition
4. Stating the input property and the as :-output relation a problem is known
(a) Specification (b) statement
(c) algorithm (d) definition

5. Ensuring the input-output relation is
(a) the responsibility of the algorithm and the right of the user.
(b) the responsibility of the user and the right of the algorithm.
(c) the responsibility of the algorithm but not the right of the user.
(d) the responsibility of both the user and the algorithm.
6. If i = 5 before the assignment i := i-1 after the assignment, the value of i is
(a) 5 (b) 4 (c) 3 (d) 2
7. If 0 < i before the assignment i := i-1 after the assignment, we can conclude that
(a) 0 < i (b) 0 ≤ i (c) i = 0 (d) 0 ≥i

Answers:
1.a 2.d 3.b 4.a 5.d 6.4 7.b

CHAPTER - 7

1. Suppose u,v = 10 ,5 before the assignment .What are the values of u and v after the sequence of assignments?
1 u := v
2 v := u
(a) u, v = 5 ,5 (b) u, v = 5 ,10 (c) u, v = 10 ,5 (d) u, v = 10 ,10
2. Which of the following properties is true after the assignment (at line 3) ?
1 -- i+j = 0
2 i, j := i+1, j-1
3 -- ?
(a) i+j >0 (b) i+j < 0 (c) i+j =0 (d) i = j
3. If C1 is false and C2 is true, the compound statement
1 if C1
2 S1
3 else
4 if C2
5 S2
6 else
7 S3
Executes
(a) S1 (b) S2 (c) S3 (d) none
4. If C is false just before the loop, the control flows through
1 S1
2 while C
3 S2
4 S3
(a) S1 ; S3 (b) S1 ; S2 ; S3 (c)S1 ; S2 ; S2 ; S3 (d) S1 ; S2 ; S2 ; S2 ; S3
5. If C is true, S1 is executed in both the flowcharts, but S2 is executed in
(a) (1) only (b) (2) only (c) both (1) and (2) (d) neither (1) nor (2)
6. How many times the loop is iterated?
i := 0
while i ≠ 5
i := i + 1
(a) 4 (b) 5 (c) 6 (d) 0

Answers:
1.a 2.c 3.b 4.a 5.a 6.b

CHAPTER - 8

1.A loop invariant need not be true
(a) at the start of the loop. (b) at the start of each iteration (c) at the end of each iteration (d) at the start of the algorithm
2.We wish to cover a chessboard with dominoes, the number of black squares and the number of white squares covered by dominoes, respectively, placing a domino can be modeled by
(a) b := b + 2 (b) w := w + 2 (c) b,w := b+1, w+1(d) b := w
3. If m x a + n x b is an invariant for the assignment a, b : = a + 8, b + 7, the values of m and n are
(a) m = 8, n = 7 (b) m = 7, n = -8 (c) m = 7, n = 8 (d) m = 8, n = -7
4. Which of the following is not an invariant of the assignment? m, n := m+2, n+3
(a) m mod 2(b) n mod 3 (c) 3 X m - 2 X n (d) 2 X m - 3 X n
5. If Fibonacci number is defined recursively as to evaluate F(4), how many times F() is applied?
(a) 3 (b) 4 (c) 8 (d) 9
6. Using this recursive definition how many multiplications are needed to calculate a10?
(a) 11 (b) 10 (c) 9 d) 8

Answers:
1.d 2.a 3.b 4.d 5.b 6.9

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