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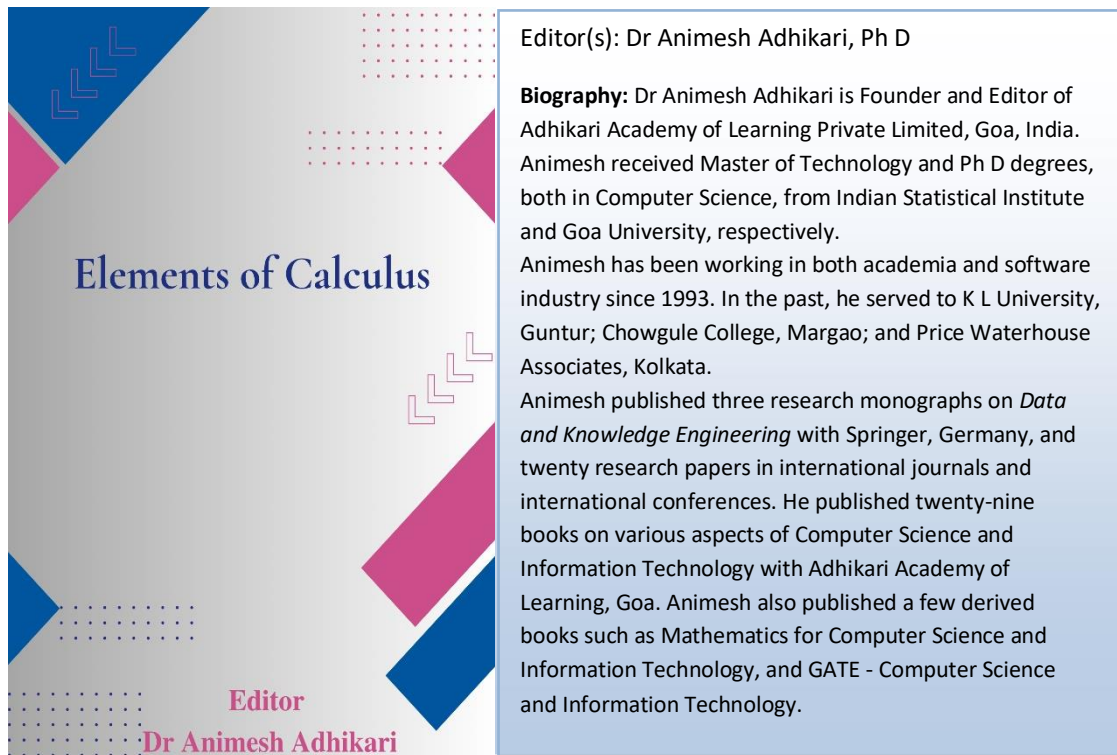
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News

We published the book *Elements of Calculus* (Second Edition) recently. Details of the book are given as follows.

The book includes interesting problems / solutions on function, limit, continuity, differentiation, integration and applications of calculus. The selection of questions / problems is aimed at providing different skills to learners. This book is also effective for students other than Computer Science, who have taken discrete mathematics or calculus as a paper of their studies. The second edition of the book contains 326 questions / solutions.



For more details about the book, please visit [book webpage](#).

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Keywords

Keyword	Question number	Page number
<i>pointer to a function</i>	1	1
<i>decidable problem</i>	4	2

1. What is a pointer to a function in C language? Illustrate this concept using a programming example.

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Answer: A pointer to a function in C language, also known as a function pointer, is a variable that stores the memory address of a function. Unlike regular pointers that point to data variables, function pointers point to the executable code of a function in memory allowing indirect calls to functions. This enables features like callback functions, dynamic function selection, and implementing object-oriented paradigms in C.

```
#include <stdio.h>

int add(int a, int b) { // adds two integers return a + b;
}
int subtract(int a, int b) { // subtracts two integers return a - b;
}

int main() {
    int (*operation)(int, int); // a function pointer that points to a
function having two integers as arguments and returns an integer.
    int c = 100, d = 10;
    operation = &add; // calls the 'add' function using the function pointer
    printf("First operand = %d \nSecond operand = %d\n", c, d);
    int temp = operation(c, d); // calls the 'add' function using the
function pointer
    printf("%d + %d = %d\n", c, d, temp);

    operation = &subtract; // calls the 'subtract' function using the
function pointer

    temp = operation(c, d); // calls the 'subtract' function using the
function pointer
    printf("%d - %d = %d\n", c, d, temp);

    return 0;
}
```

The output of the program is given below.

```
First operand = 100
Second operand = 10
100 + 10 = 110
100 - 10 = 90
```

NOTE: We have used the following online C compiler to execute the above program:

<https://www.programiz.com/c-programming/online-compiler/>

2. Using graph theory, explain whether it is possible for each person, in a group of 15 individuals, to have exactly three friends. (Assume that friendship is a symmetric relation, i.e. friendship goes both ways.)

Answer: It is not possible. Justification is given as follows.

We construct a graph, where each person represents a vertex, and an edge between two vertices denotes friendship. Suppose each person has exactly three friends. This implies that the degree of every vertex is 3. Again, each edge contributes 2 degrees. So, total sum of degrees of a graph is even. (1)

Then the number of odd-degree vertices must be even to ensure the total sum of degrees remains even. In this particular case, the number of vertices (persons) is 15 (an odd number), and each vertex has degree 3 (an odd number). So, total sum of degrees is $15 \times 3 = 45$ (an odd number). This statement contradicts the statement (1). Thus, it is impossible to have the given set-up.

3. If $\lim_{x \rightarrow 1} \left[\frac{1}{2(x-1)} - \frac{1}{(x-1)^2} + \frac{\ln x}{(x-1)^3} \right] = \frac{1}{a}$, find a .

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$$\text{Answer: } \lim_{x \rightarrow 1} \left[\frac{1}{2(x-1)} - \frac{1}{(x-1)^2} + \frac{\ln x}{(x-1)^3} \right] = \lim_{x \rightarrow 1} \frac{(x-1)^2 - 2(x-1) + 2 \ln x}{2(x-1)^3}$$

$$= \lim_{y \rightarrow 0} \frac{y^2 - 2y + 2 \ln(1+y)}{2y^3}, \text{ where } y = x - 1$$

$$= \lim_{y \rightarrow 0} \frac{y-2}{2y^2} + \lim_{y \rightarrow 0} \frac{1}{y^2} \times \lim_{y \rightarrow 0} \frac{1}{y} \ln(1+y)$$

$$= \infty + \infty \times 1, \text{ since } \lim_{y \rightarrow 0} \frac{1}{y} \ln(1+y) = 1$$

$$= \infty$$

$$\text{Then, } \frac{1}{a} = \infty$$

Therefore, $a = 0$.

4. Consider the following decision problems.

(P1) Does a given finite state machine accept a given string

(P2) Does a given context-free grammar generate an infinite number of strings

Which of the following statements is true?

(a) Both (P1) and (P2) are decidable

(b) Neither (P1) or (P2) are decidable

(c) Only (P1) is decidable

(d) Only (P2) is decidable

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Answer: A decidable problem can be solved by an algorithm that halts on all inputs in a finite number of steps. A finite state machine will always halt, unlike some other models of computation such as Turing machine.

Given any finite state machine and string, one can simulate the machine's execution on the string and determine if it accepts the string or not. Thus, statement (P1) is decidable. So, options (b) and (d) are not correct.

Now, we talk about the second decision problem (P2). There exists an algorithm that can transform a context-free grammar (CFG) into Chomsky Normal Form (CNF). Also, one can create a "Reachability"

graph from productions of CNF. There exists an algorithm to detect cycles in the reachability graph. If there is a cycle in this graph, the CGF generates an infinite language; otherwise, it does not. So, the option (a) is correct.

5. The simultaneous equations on the Boolean variables x, y, z and w ,

$$x + y + z = 1$$

$$xy = 0$$

$$xz + w = 1$$

$$xy + \bar{z}\bar{w} = 0$$

have the following solution for x, y, z and w , respectively.

(a) 0 1 0 0 (b) 1 1 0 1 (c) 1 0 1 1 (d) 1 0 0 0

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Answer: We number the equations.

$$x + y + z = 1 \tag{2}$$

$$xy = 0 \tag{3}$$

$$xz + w = 1 \tag{4}$$

$$xy + \bar{z}\bar{w} = 0 \tag{5}$$

Solution (b) is not correct, since it does not satisfy equation (3).

Solution (d) is not correct, since it does not satisfy equation (5).

Solution (a) is not correct, since it does not satisfy equation (4).

Thus, option (c) is the solution.

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