CHAPTER 3

PROBLEMS INVOLVING LOOPING

INTRODUCTION

In the flowcharts of the preceding chapter, we demonstrated the sequence and selection logic structures. We now move to the iteration logic structure.

The term *iteration* means repetition. Sometimes, a procedure should be executed repeatedly. All procedures should be built so that they can be repeated as many times as needed. We should not develop procedures to execute only once. Otherwise, calculators could be sufficient to obtain the results. An iterative logic structure is also known as a *loop*. *Looping* means repeating a set of operations to obtain a result repeatedly.

An iteration may be implemented in two ways: a pre-test iteration and post-test iteration. In case of a *pre-test iteration*, a predicate is tested to decide whether a set of operations is to be performed or not. If the condition implied by the predicate is true, then the desired operations are performed. If it is false, then the iteration is terminated. This is shown in the following diagram.

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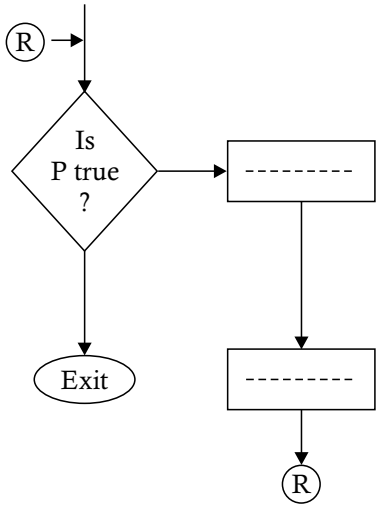
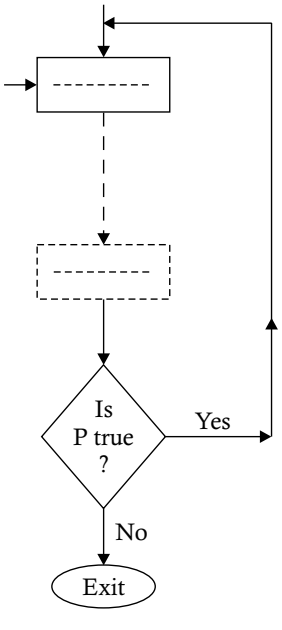


For a post-test iteration, the predicate is tested after performing a set of operations once to decide whether to repeat the set of operations or to terminate the repetition. If the condition happens to be true, then the set of operations is repeated; otherwise, it is not repeated. The diagrammatic structure of this logic is as follows.



Note that the operations in the loop must be performed at least once in the case of a post-test iteration.

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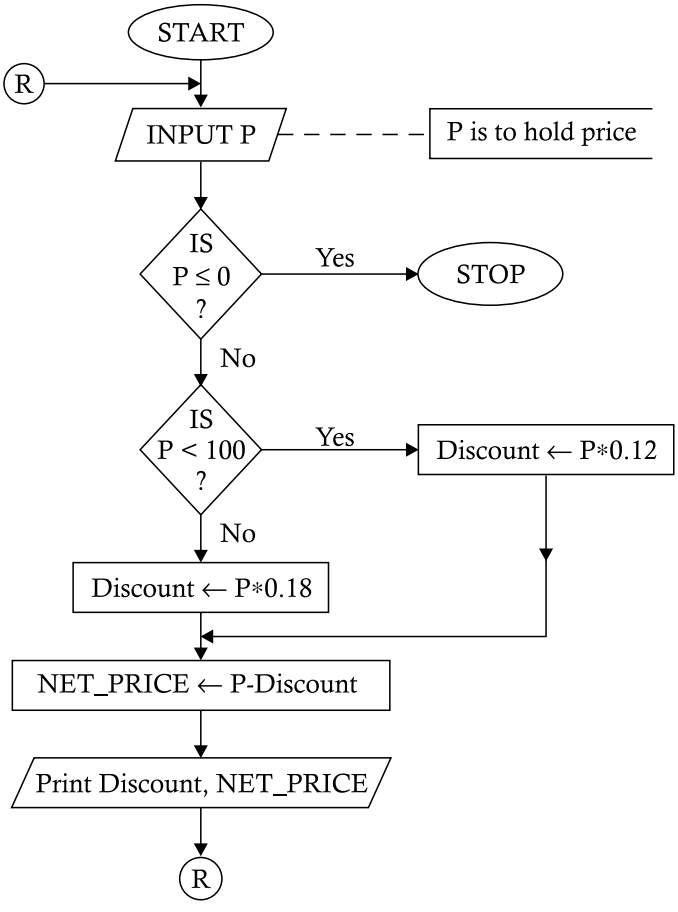
The concept of looping is demonstrated in the following flowchart. Of course, there should be a condition for normal termination. Let us assume that the repetitive task of calculating the discounts and net prices is terminated when we provide negative or zero as the price for the input. Such absurd values are justified for the termination of loops so that the procedure can remain valid for any possible value of the price. We usually use out-connectors and in-connectors with the same label to demonstrate the end point and start point of a loop. These are shown in the flowchart of Problem 2.11.

The algorithm corresponding to the flowchart is below:

Step 1. REPEAT STEPS 2 THROUGH 6 (Start Loop)
Step 2. INPUT TO P
Step 3. IF P ≤ 0 THEN EXIT (Stop Repetition, *i.e.*, transfer the control to STOP).



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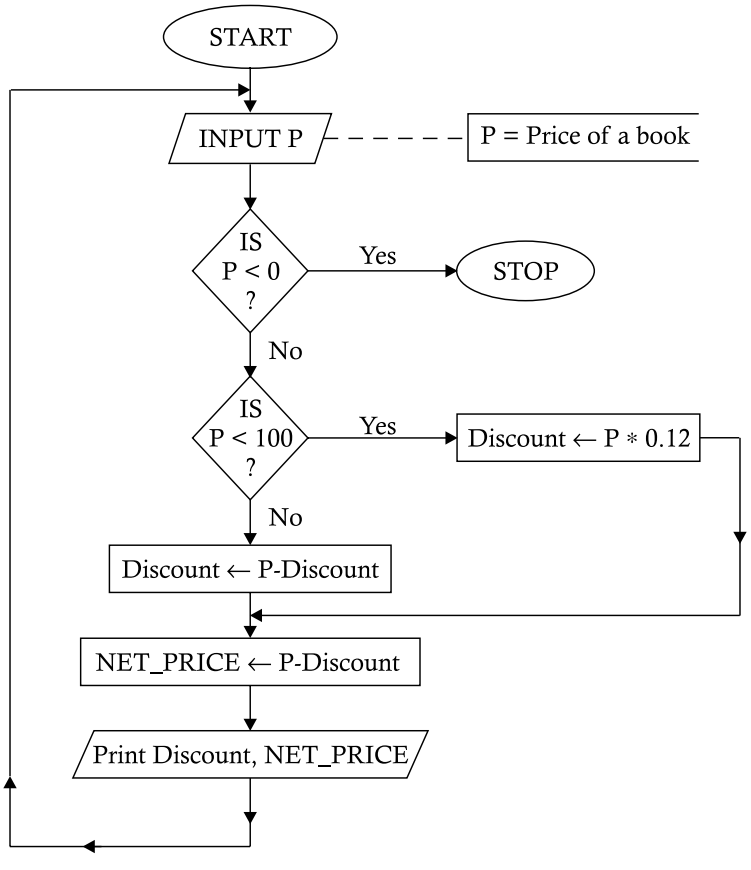
Step 4. If P < 100
THEN COMPUTE D ← P*0.12
ELSE COMPUTE D ← P*0.18
END-IF
Step 5. COMPUTE NET_PRICE ← P – D
Step 6. PRINT D, NET_PRICE (End of loop)
Step 7. STOP

Note that the out-connector (R) shows the end point of the loop and the in-connector. (R)⟶ shows the start point of the loop. The operations starting from the point of the accepting the input price up to the points of printing the output discount and net price are within the loop. It could have been demonstrated without using connectors.

However, we prefer the first flowchart to the following one, because if the flowchart cannot be accommodated on a single page (or in a continuous structure on a single page), it would be difficult or impossible difficult to connect the start point and the end point.



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Problem 3.1. *The salesmen of a sales firm are given a commission on sales achieved, using the following rules:*

Sales	*Rate of commission*
<= 5,000	*7% of sales*
> 5,000 but <= 10,000	*9% of sales + $500*
> 10,000 but <= 20,000	*11% of sales + $1,000*
> 20,000 but <= 25,000	*13% of sales + $2,000*
> 25,000	*15% of sales + $4,000*

Devise a procedure to calculate the commission of the salesmen.

Task Analysis. The output required is the commission earned by a salesman. The only input required is the amount of the sale. A number of decision-making steps are involved, and the process is likely to be repeated a number of times. Let us assume that the process can be terminated when the amount of the sale is zero or negative. The procedure is illustrated in the following flowchart.

The algorithm corresponding to Problem 3.1 is given below:

```
Step 1.  REPEAT STEPS 2 THROUGH 5
Step 2.  INPUT TO S
         (Accept sales amount in S)
Step 3.  If S <= 0
           THEN EXIT
         END-IF
Step 4.  IF S <= 5000
           THEN COMPUTE COM ← S * .07
         ELSE
           IF S <= 10000
             THEN COMPUTE COM ← S * .09 + 500
           ELSE
             IF S <= 20000
               THEN COMPUTE COM ← S * 0.11 + 1000
             ELSE
               IF S <= 25000
                 THEN COMPUTE COM ← S * 0.13 + 2000
               ELSE
                 COMPUTE COM ← S * 0.15 + 4000
               END-IF
             END-IF
           END-IF
         END-IF
Step 5.  PRINT COM
Step 6.  STOP
```

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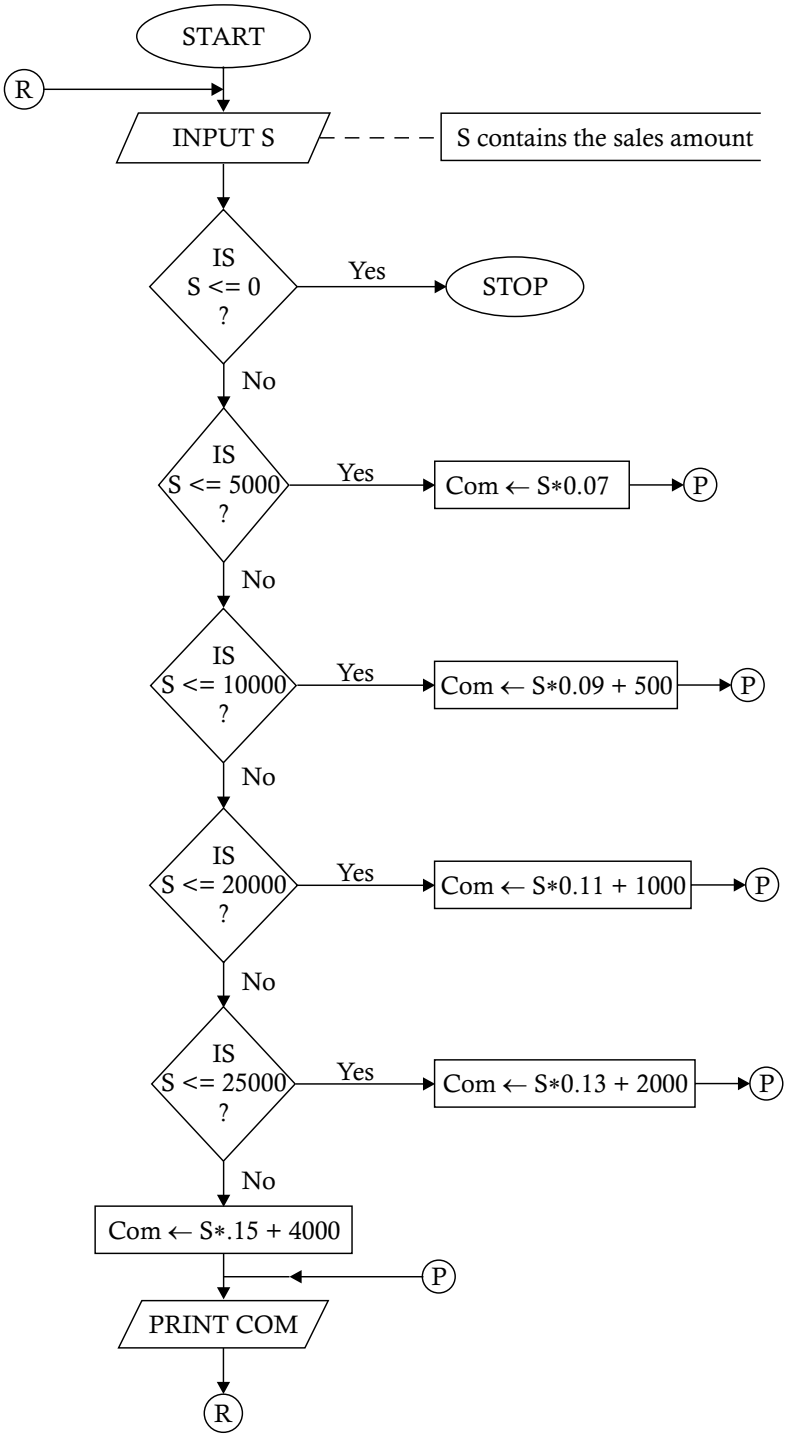

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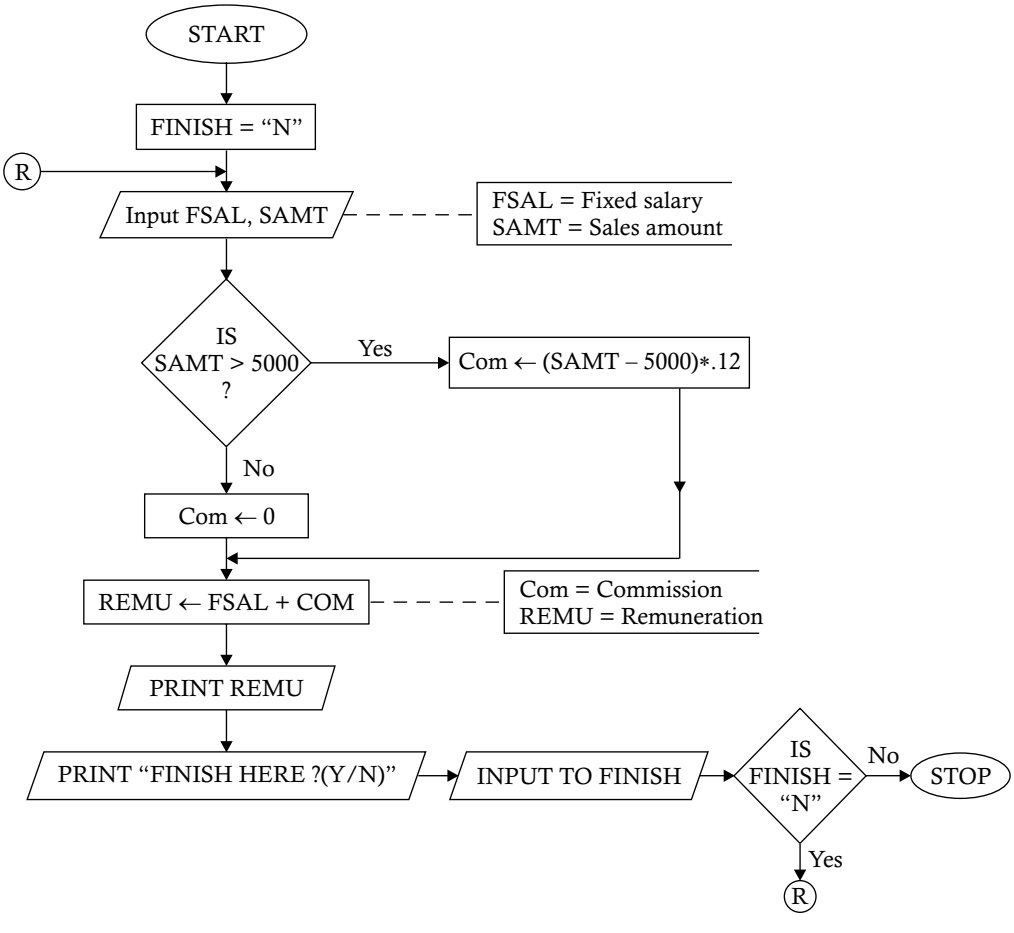
Problem 3.2. *A sales organization offers a fixed salary and a percentage of sales as a commission to determine the monthly remuneration of an employee under the following conditions.*

If the sales amount of an employee exceeds $5,000, then the commission is 12% of the sales that exceed $5,000; otherwise, it is nil. Draw a flowchart to show how the remuneration of an employee is decided.

Task Analysis. The remuneration of an employee consists of two parts: a fixed salary part and a commission part that depends on the sales amount. We use the fixed salary part and the sales amount as input to determine the commission and hence, the remuneration.



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The algorithm corresponding to Problem 3.2 is given below:

Step 1. FINISH ← "N"
Step 2. REPEAT STEPS 3 THROUGH 9 WHILE FINISH = "N"
Step 3. INPUT TO FSAL, SAMT
Step 4. IF SAMT > 5000
  THEN COMPUTE COM ← (SAMT – 5000) * .12
  ELSE
  COM ← 0
  END-IF
Step 5. COMPUTE REMU ← FSAL + COM
Step 6. PRINT "REMUNERATION IS", REMU
Step 7. PRINT "FINISH (Y/N)?"
Step 8. INPUT TO FINISH
Step 9. IF FINISH = "Y"
  THEN EXIT
  END-IF
Step 10. STOP

Problem 3.3. *A labor contractor pays the workers at the end of each week according to the rules given below:*

For the first 35 hours of work, the rate of pay is $15 per hour; for the next 25 hours, the rate of pay is $18 per hour; for the rest, the rate of pay is $26 per hour. No worker is allowed to work for more than 80 hours in a week. Develop a flowchart to show how the wages of the workers can be calculated on the basis of valid inputs.

Task Analysis. The input required is the total number of hours worked. The rates of payment depend on the different numbers of hours worked. The total hours worked may be considered valid if the number lies in the range of 0 through 80. Our procedure for evaluating the wage consists of the (*i*) validation of the hours worked, (*ii*) identifying the category to which the hours worked pertain, and then (*iii*) applying different rates to calculate the wage. The procedure is shown within a loop, and it is terminated when zero or a negative value is given as the input against hours worked.

The algorithm corresponding to Problem 3.3 is given below:

Step 1. REPEAT STEPS 2 THROUGH 6
Step 2. INPUT TO TH
Step 3. IF TH <= 0
  THEN EXIT
  END-IF

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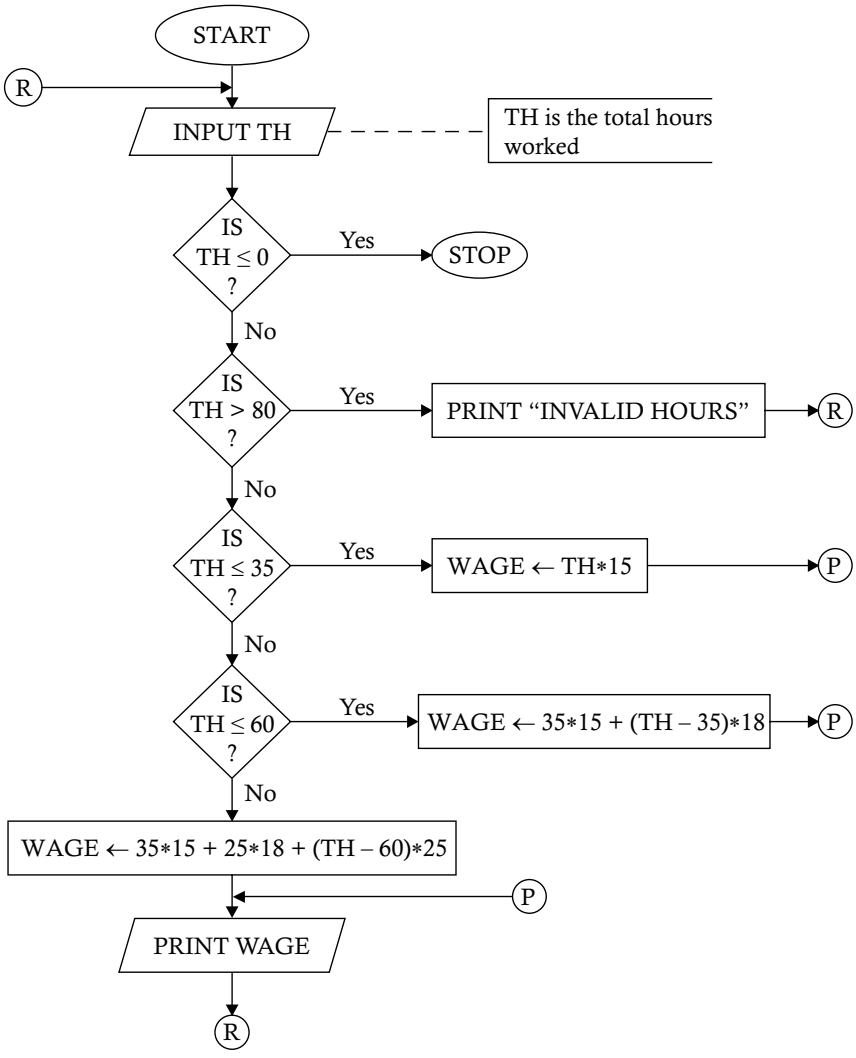

Step 4. IF TH > 80
THEN PRINT "INVALID HOURS"
CONTINUE
END-IF

Step 5. IF TH <= 35
THEN COMPUTE WAGE ← TH*15
ELSE
IF TH <= 60
THEN COMPUTE WAGE ← 35*15 + (TH–35)*18

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```
        ELSE
          COMPUTE WAGE ← 35*15 + 25*18 + (TH–60)*25
        END-IF
      END-IF
Step 6. PRINT "WAGE IS", WAGE
Step 7. STOP
```

Problem 3.4. *In New Delhi, the telephone bill is calculated according to the following rules for the first 300 calls, the bill is fixed and it is equal to Rs. 500; for the next 65 calls, the rate per call is Re. 0.95; for the next 90 calls, the rate per call is Rs. 1.50; for calls beyond that the rate per call is Rs. 2.25 per call.*

Develop a flowchart to show how the telephone bill is calculated.

Task Analysis. The input required is the number of calls and the output required is the total bill for the telephone calls. Note that the rates vary only for the excess number of calls in a particular category. The following flowchart demonstrates the formulas for calculating the bill.

The algorithm of the solution for Problem 3.4 is given below:

```
Step 1. REPEAT STEPS 2 THROUGH 5 UNTIL CALLS < 0
Step 2. INPUT TO CALLS
Step 3. IF CALLS < 0 THEN EXIT
Step 4. IF CALLS < = 300
          THEN BILL ← 500
        ELSE
          IF CALLS <= 365
            THEN COMPUTE BILL ← 500 + (CALLS – 300) * 0.95
          ELSE
            IF CALLS <= 455
            THEN COMPUTE BILL ← 500 + 65*0.95 + (CALLS –
            365)*1.50
          ELSE
            COMPUTE BILL ← 500 + 65*0.95 + 90*1.50 + (CALLS –
            455)*2.25
            END-IF
          END-IF
        END-IF
Step 5. PRINT "THE TELEPHONE BILL IS", BILL
Step 6. STOP
```

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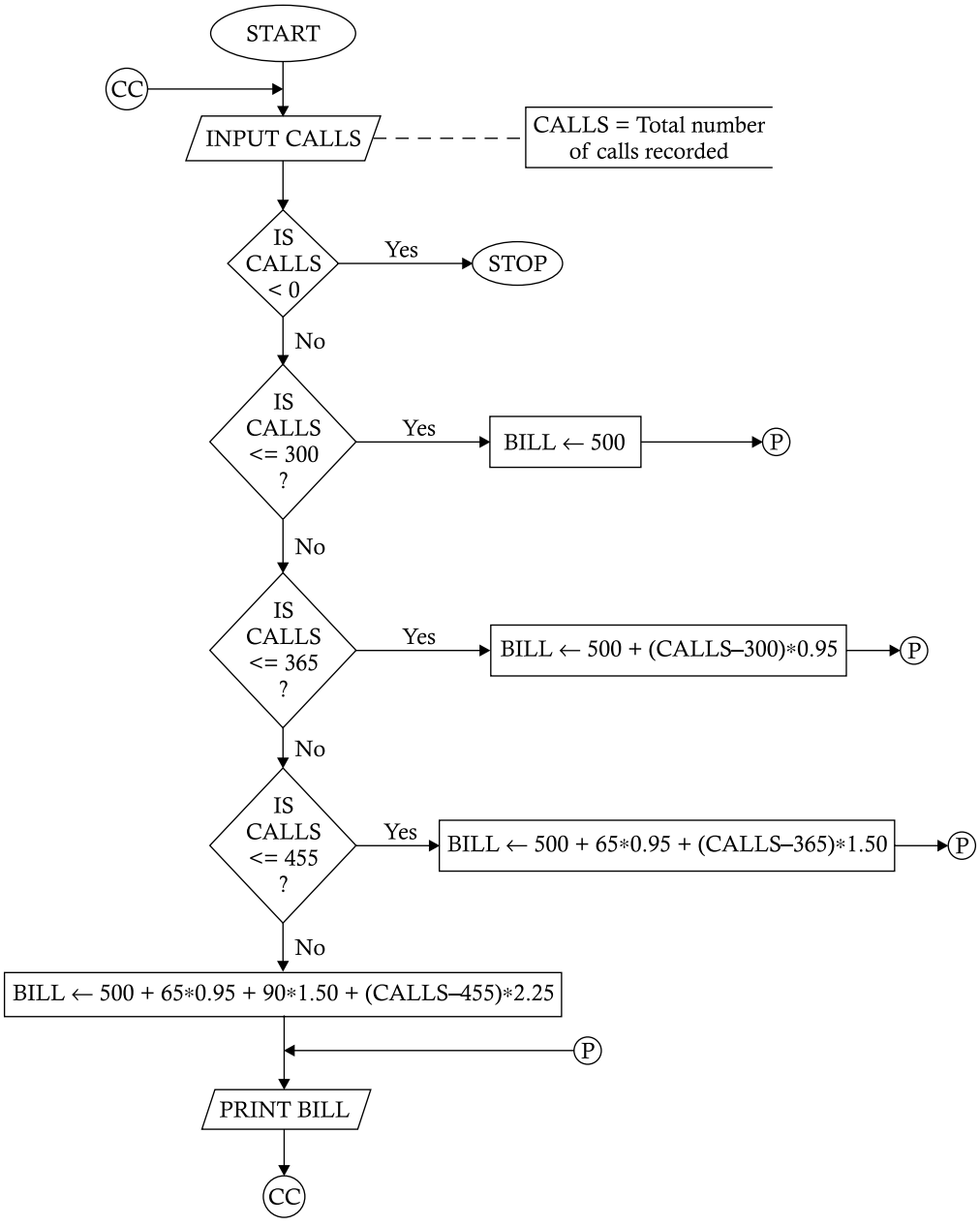

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