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IF 130
Programming Fundamentals

01 Algorithm and Flowchart of Selection Control Structure

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Course Learning Outcome:

1. Students are able to explain the definitions of algorithms, flowcharts, and pseudocode (C2).
2. Students are able to apply the problem-solving process using algorithms in the form of flowcharts and pseudocode (C3).
3. Students are able to draw flowcharts with selection control structures, repetition control structures, and modularization control structures (C3).

Program Design

- Programming can be defined as the development of a solution to an **identified problem**, and the setting up of a related series of **instructions** that, when directed through computer hardware, will produce the **results.**
- Leaping straight into the coding phase **without first designing** a proper solution usually results in a program that contains **many errors.**
- A more experienced programmer **will design a solution** to the program first, **desk check this solution**, and then **code the program** in a chosen programming language.

Basic Steps in The Development of a Program

1. Define the problem
2. Outline the solution
3. Develop the outline into an algorithm
4. Test the algorithm for correctness
5. Code the algorithm into a specific programming language
6. Run the program on the computer
7. Document and maintain the program

What is an algorithm?

- An algorithm is like a **recipe**: it lists the steps involved in accomplishing a task.
- It can be defined in programming terms as a set of *detailed, unambiguous and ordered* instructions developed to describe the **processes** necessary to produce the desired **output** from a given **input**.
- **Flowchart** and **pseudocode** are both popular ways of **representing algorithms.**

Algorithm Example

If you want to instruct someone to **add up a list of prices** on a pocket calculator, you might write an algorithm such as the following:

Turn on calculator
Clear calculator
Repeat the following instructions
    Key in dollar amount
    Key in decimal point (.)
    Key in cents amount
    Press addition (+) key
Until all prices have been entered
Write down total price
Turn off calculator

What is flowchart?

- Pseudocode and flowchart are both popular ways of **representing algorithms.**
- Flowchart are popular because they graphically represent the program logic by a series of **standard geometric symbols** and **connecting lines.**
- Flowchart are **relatively easy to learn** and are an intuitive method of representing the flow of control in an algorithm.

What is pseudocode?

- **Pseudocode** and **flowchart** are both popular ways of representing algorithms.
- There is no standard pseudocode at present.
- Like many version of pseudocode, this version has certain conventions:
  1. Statements are written in simple English
  2. Each instruction is written on a separate line
  3. Keywords and indentation are used to signify particular control structures
  4. Each set of instructions is written from top to bottom, with only one entry and one exit
  5. Groups of statements may be formed into modules, and that module given a name

The Three Basic Control Structures

1. **Sequence**

   The sequence control structure is the straightforward **execution of one processing step after another.**

2. **Selection**

   The selection control structure is **the presentation of a condition and the choice** between two actions, the choice depending on whether the condition is **true** or **false**.

3. **Repetition**

   The repetition control structure can be defined as the presentation of a set of **instructions to be performed repeatedly**, as long as a **condition is true.**

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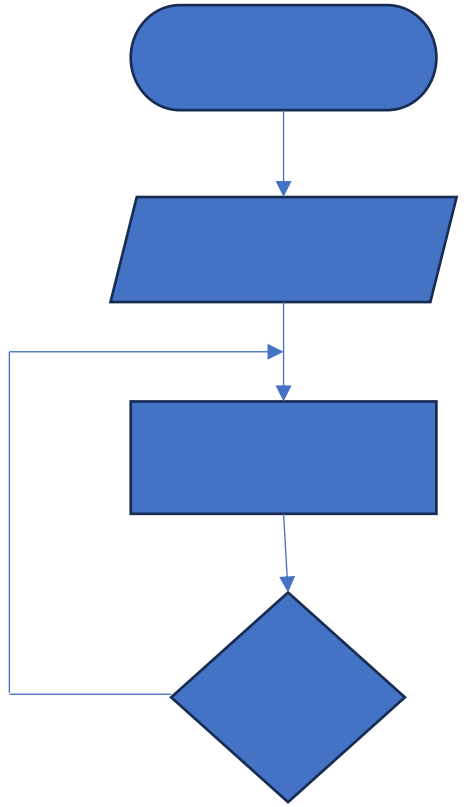
Introduction to Flowcharts



6 Standard flowchart symbols

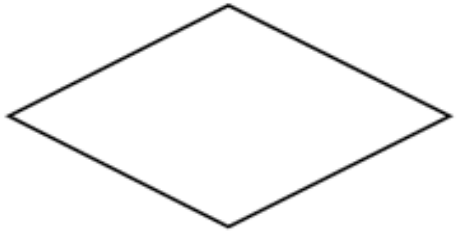
Terminal symbol
The terminal symbol indicates the starting or stopping point in the logic. Every flowchart should begin and end with a terminal symbol.

Input/Output symbol
The input/output symbol represents an input or output process in an algorithm, such as reading input or writing output.

Process symbol
The process symbol represents any single process in an algorithm, such as assigning a value or performing a calculation. The flow of control is sequential.

6 Standard flowchart symbols

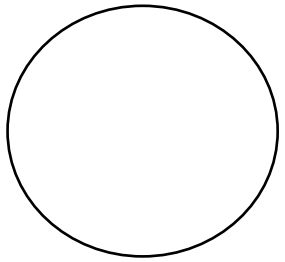
Predefined process symbol
The predefined process symbol represents a module in an algorithm – that is, a predefined process that has its own flowchart.



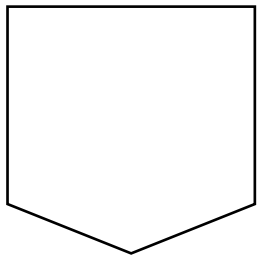
Decision symbol
The decision symbol represents a decision in the logic involving the comparison of two values. Alternative paths are followed, depending on whether the decision symbol is true or false.

Flowlines
Flowlines connect various symbols in a flowchart, and contain an arrowhead only when the flow of control is not from top to bottom or left to right.

6 Standard flowchart symbols



Connector symbol

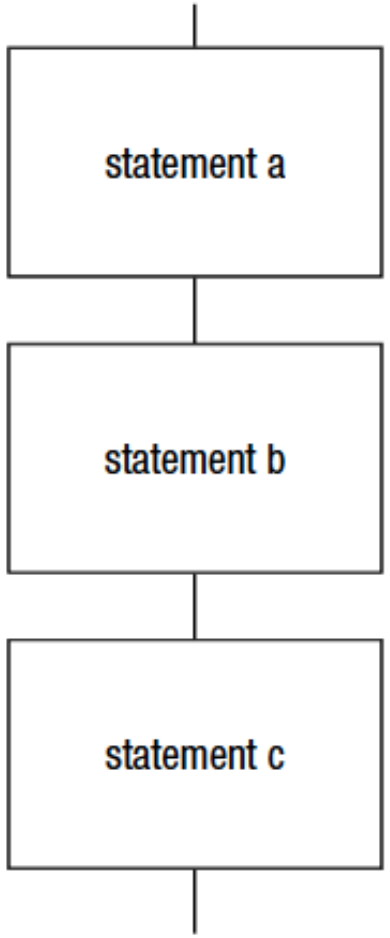


Off page connector symbol

- In flowcharts, this symbol is typically small and is used as a **connector** to **show a jump** from one point in the process flow to another.
- Connectors are **usually labeled with capital letters** (A, B, AA) to show matching jump points

Flowchart : Sequence Control Structure

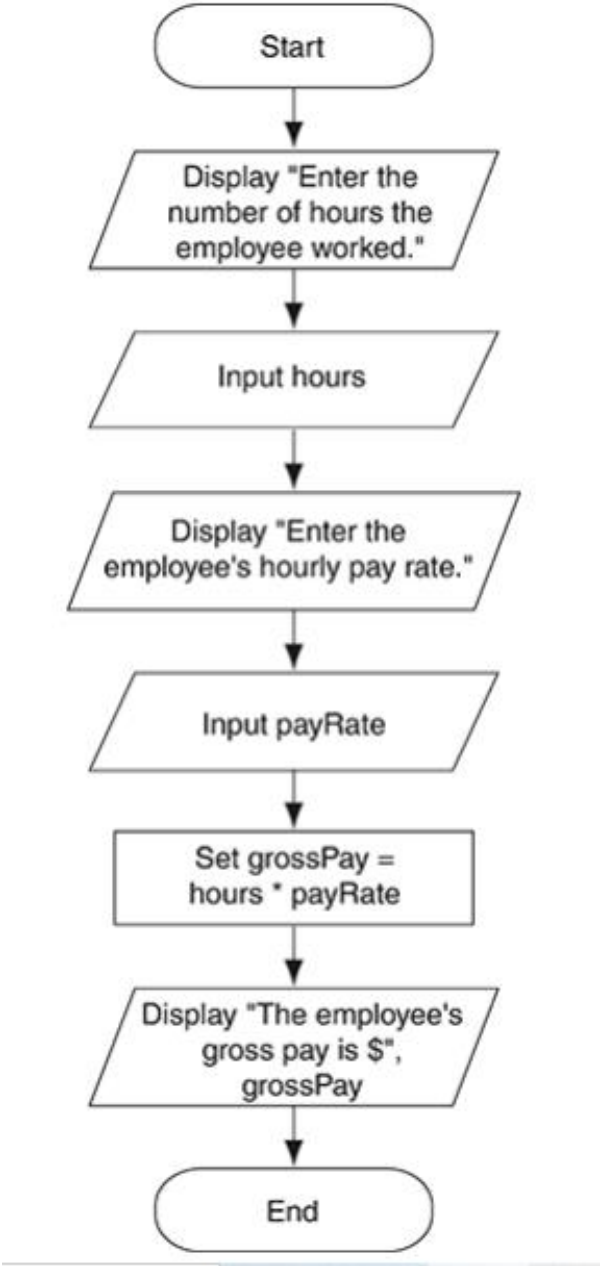
- A flowchart represents this control structure as a series of process symbols, one beneath the other, with one **entrance** and one **exit**



Sequence Flowchart Example

For example, suppose you have been asked to write a program to calculate and display the gross pay for an hourly paid employee. Here are the steps that you would take:

1. Get the number of hours worked.
2. Get the hourly pay rate.
3. Multiply the number of hours worked by the hourly pay rate.
4. Display the result of the calculation that was performed in Step 3.



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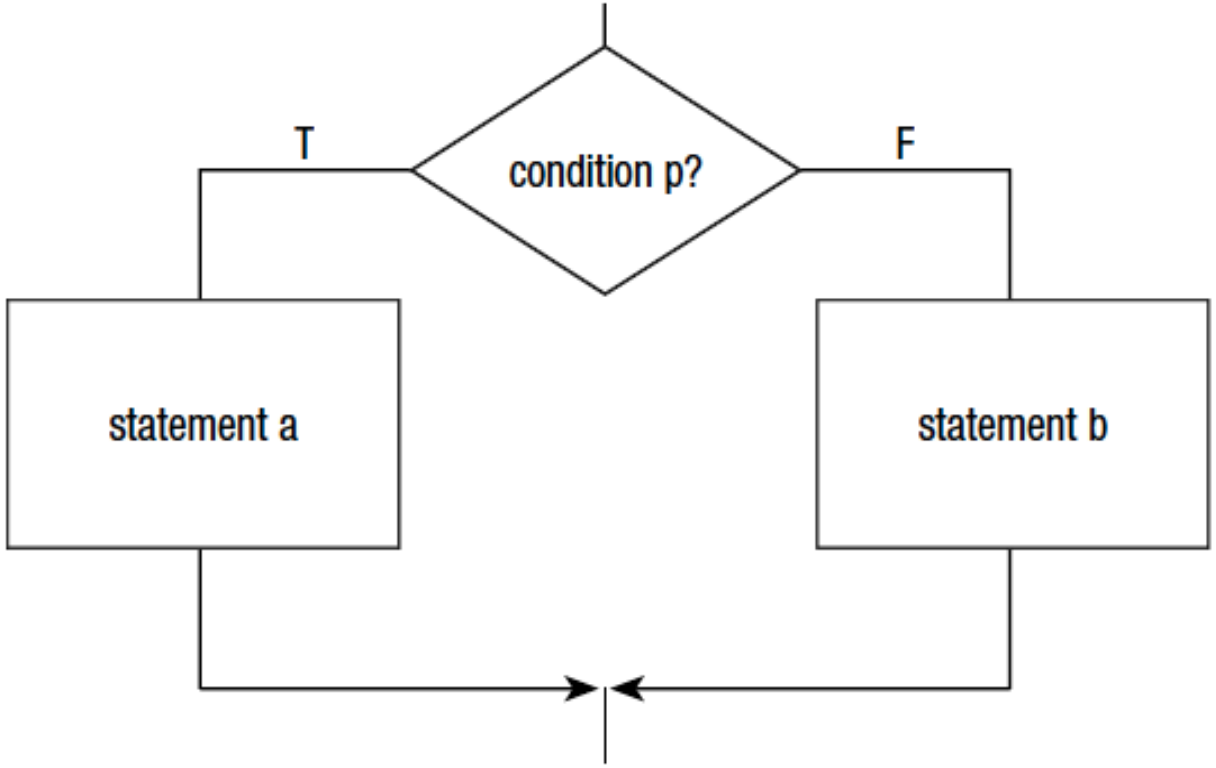
Flowcharts and The Selection Control Structure

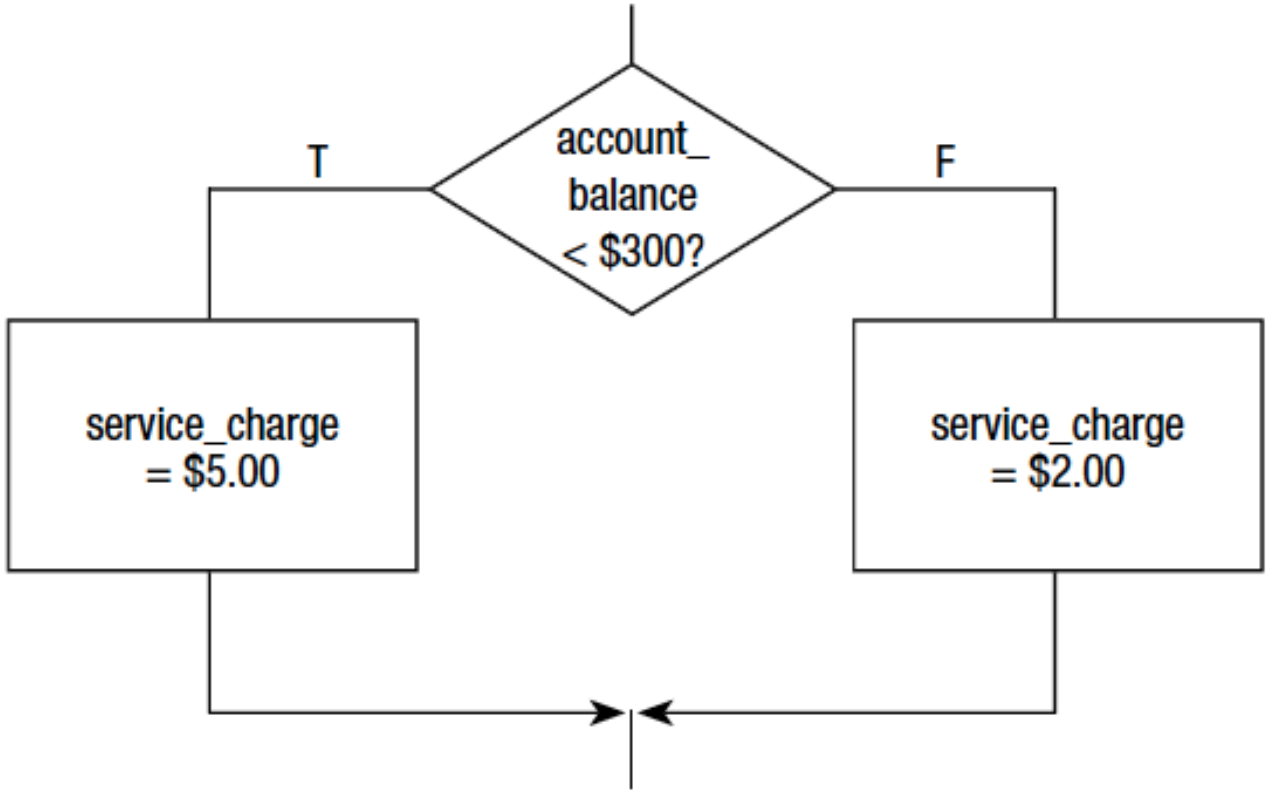
Selection Control Structure

- The selection control structure can be defined as the presentation of a condition, and the choice between two actions depending on whether the condition is **true** or **false**.



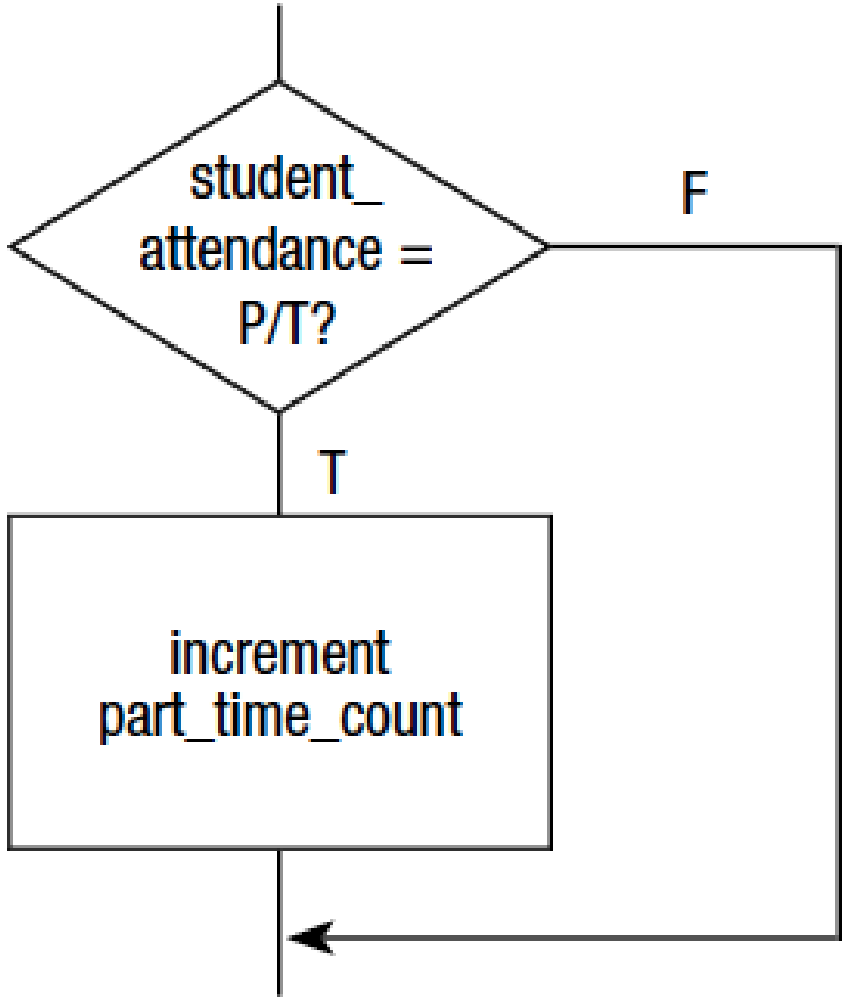
Simple IF Statement

- Simple selection occurs when a choice is made between two alternative paths, depending on the result of a condition being true or false.
- This structure is represented in a flowchart as follows:



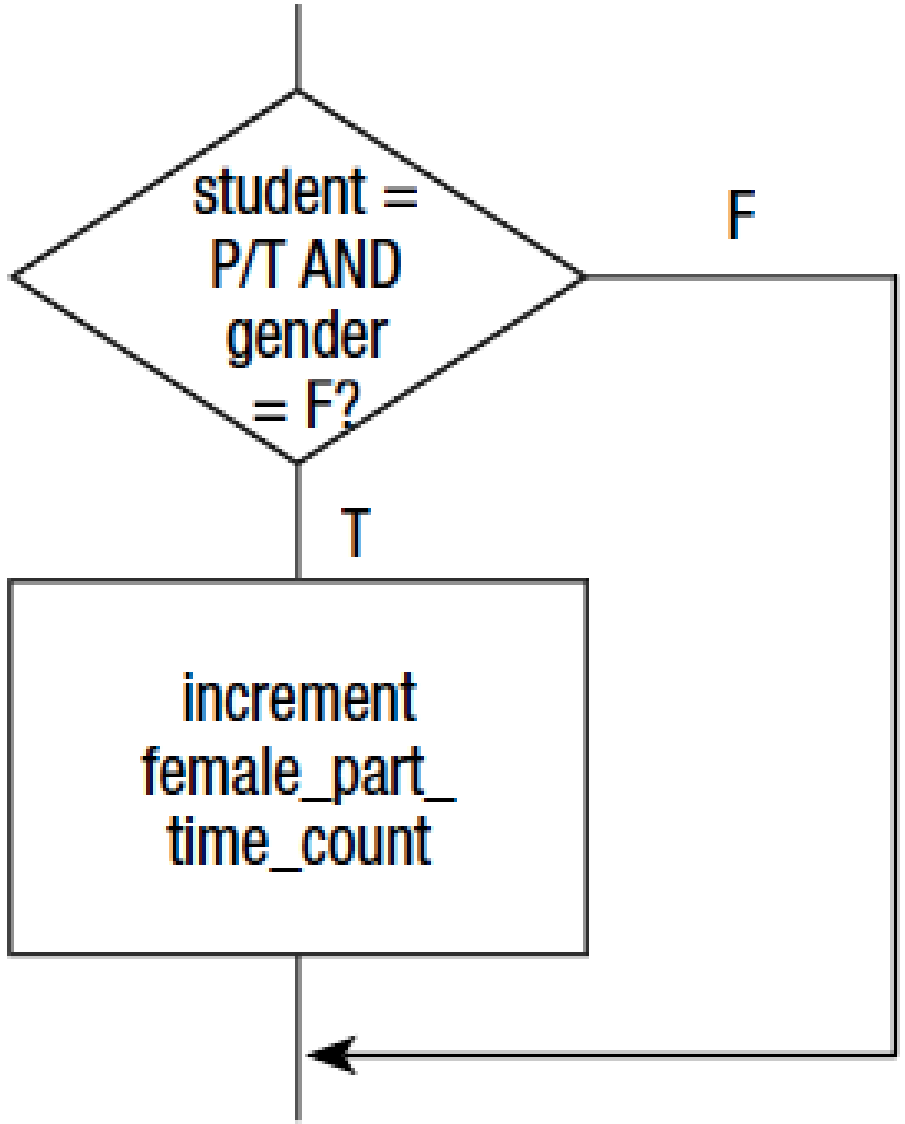
Null ELSE Statement

- The null ELSE structure is a **variation** of the simple IF structure.
- It is used when a task is performed only when a particular condition is true.
- If the condition is **false, no processing** will take place, and the IF statement will be bypassed.



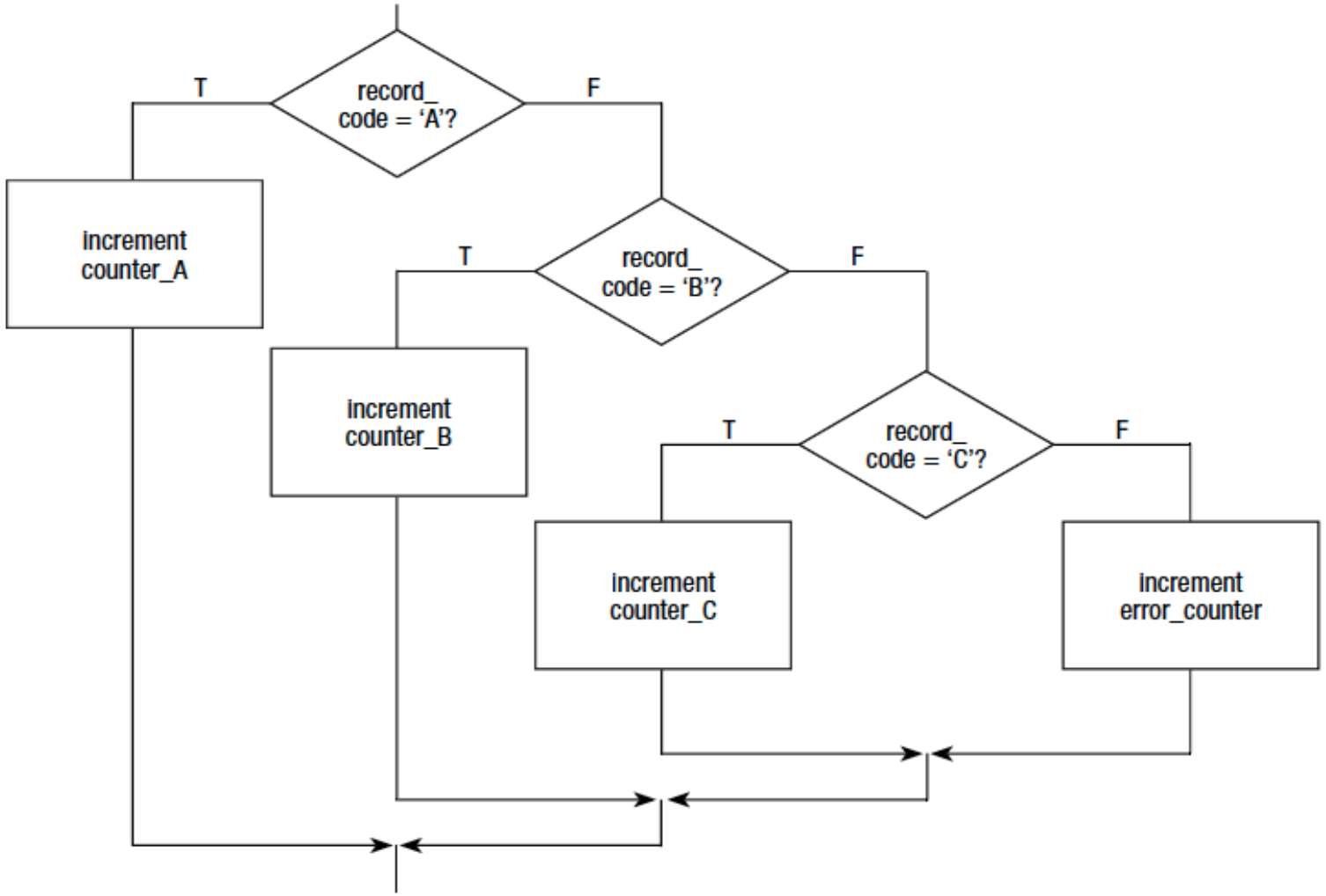
Combined IF Statement

- A combined IF statement is one that contains multiple conditions in the decision symbol, each connected with the logical operators **AND** or **OR.**
- If the connector **AND** is used to combine the conditions, then both conditions must be true for the combined condition to be true.



Nested IF Statement

- The nested IF statement is used when a field is being tested for various values, with different action to be taken for each value.
- In a flowchart, this is represented by a **series** of decision symbols



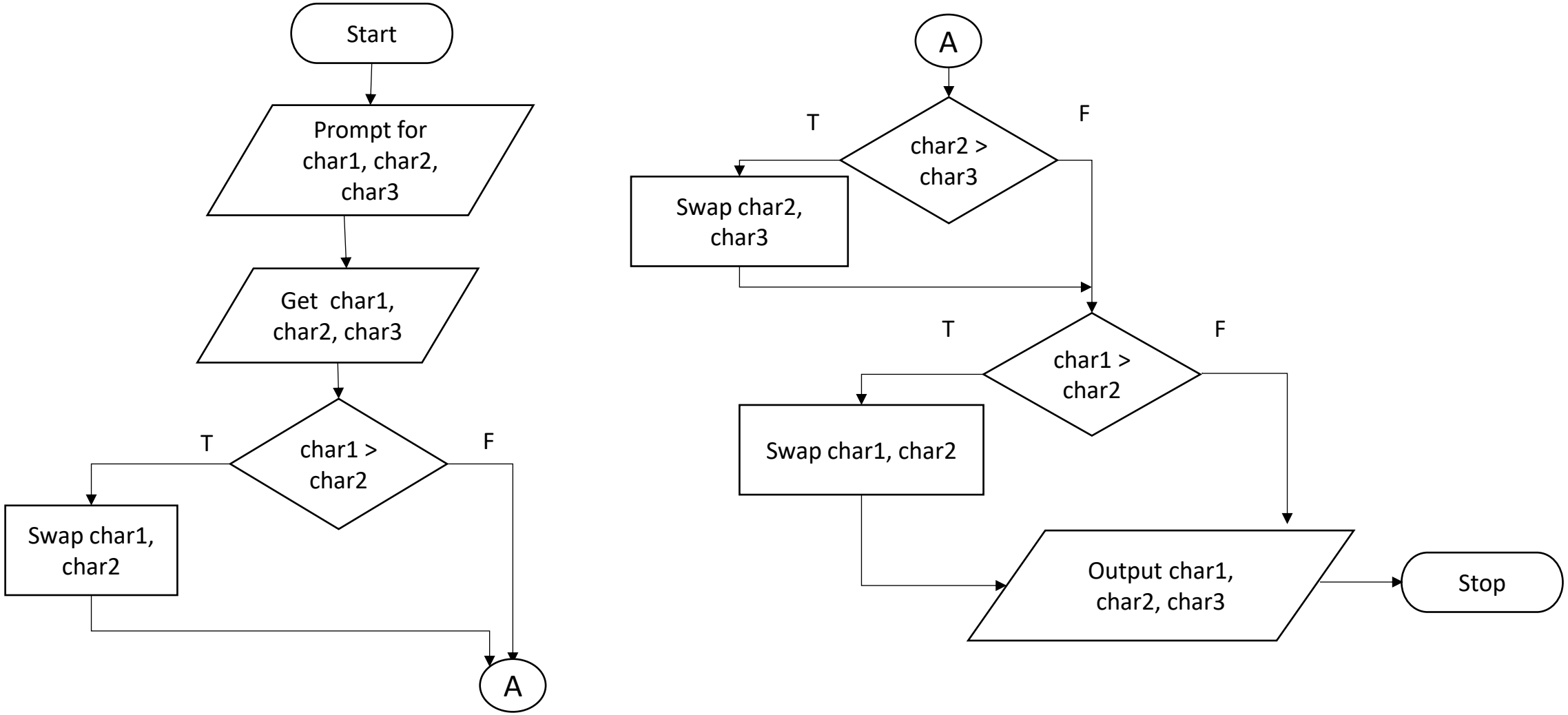
Example 1: Read three characters

Design an algorithm that will prompt a terminal operator for three characters, accept those characters as input, sort them into **ascending** and output them to the screen.

Example 1: Read three characters

Input	Processing	Output
char_1 char_2 char_3	Prompt for characters Accept three characters Sort three characters Output three characters	char_1 char_2 char_3

Example 1: Read three characters



Example 2: Process customer record

A program is required to read a customer's name, a purchase amount and a tax code. The tax code has been validated and will be one of the following:

0 – tax exempt (0 %)

1 – state sales tax only (3 %)

2 – federal and state sales tax (5 %)

3 – special sales tax (7 %)

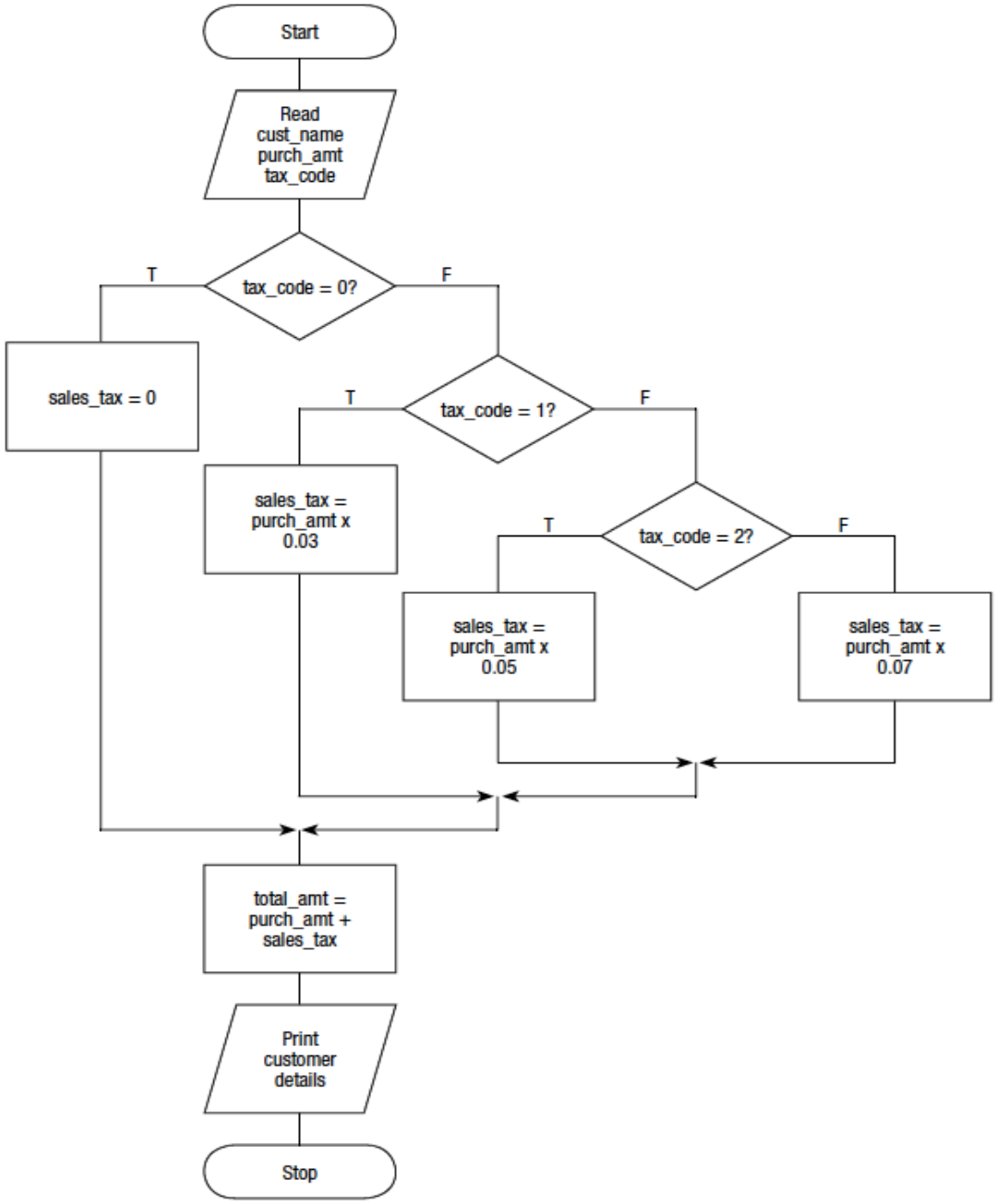
The program must then compute the sales tax and the total amount due, and print the customer's name, purchase amount, sales tax and total amount due.

Example 2: Process customer record

Defining diagram

Input	Processing	Output
cust_name	Read customer details	cust_name
purch_amt	Compute sales tax	purch_amt
tax_code	Compute total amount	sales_tax
	Print customer details	total_amt

Example 2:


Start
Read
cust_name
purch_amt
tax_code
tax_code = 0?
T
F
sales_tax = 0
tax_code = 1?
T
F
sales_tax =
purch_amt x
0.03
tax_code = 2?
T
F
sales_tax =
purch_amt x
0.05
sales_tax =
purch_amt x
0.07
total_amt =
purch_amt +
sales_tax
Print
customer
details
Stop

Example 3: Calculate employee's pay

A program is required by a company to read an employee's number, pay rate and the number of hours worked in a week. The program is then to validate the pay rate field and the hours work field and, if valid, compute the employee's weekly pay and then print it and the input data.

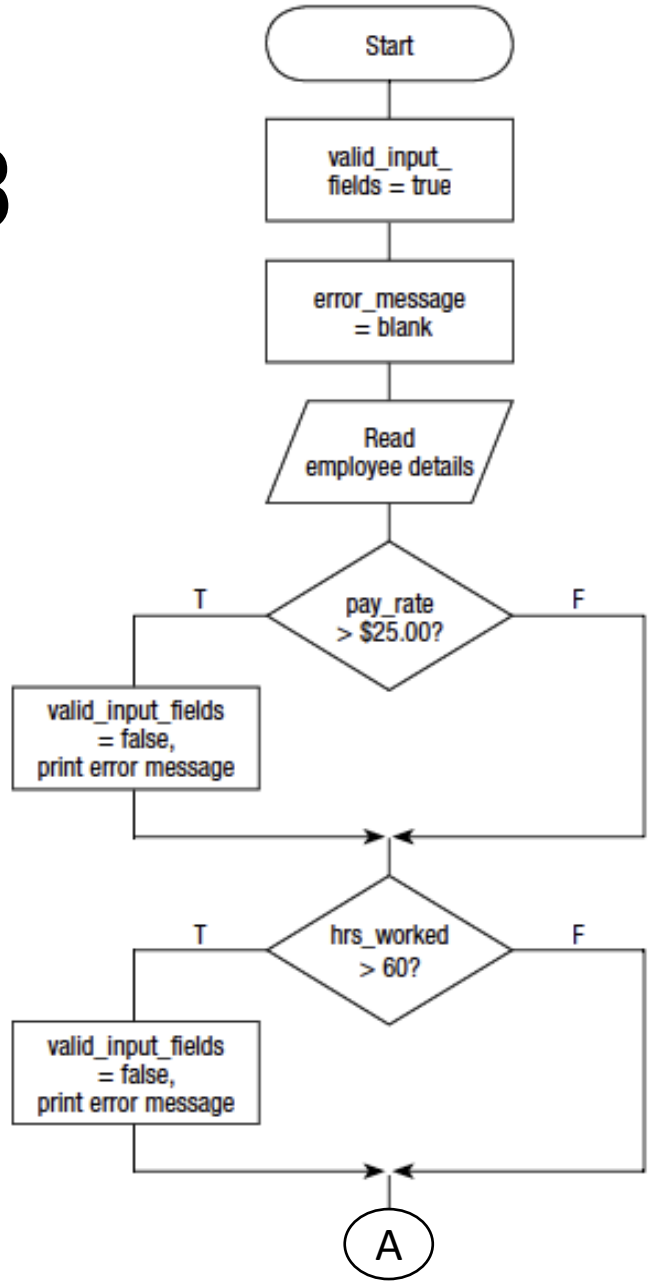
Validation: According to the company's rules, the maximum hours an employee can work per week is 60 hours, and the maximum hourly rate is $25.00 per hour. If the hours worked field or the hourly rate field is out of range, the input data and an appropriate message are to be printed and the employee's weekly pay is not to be calculated.

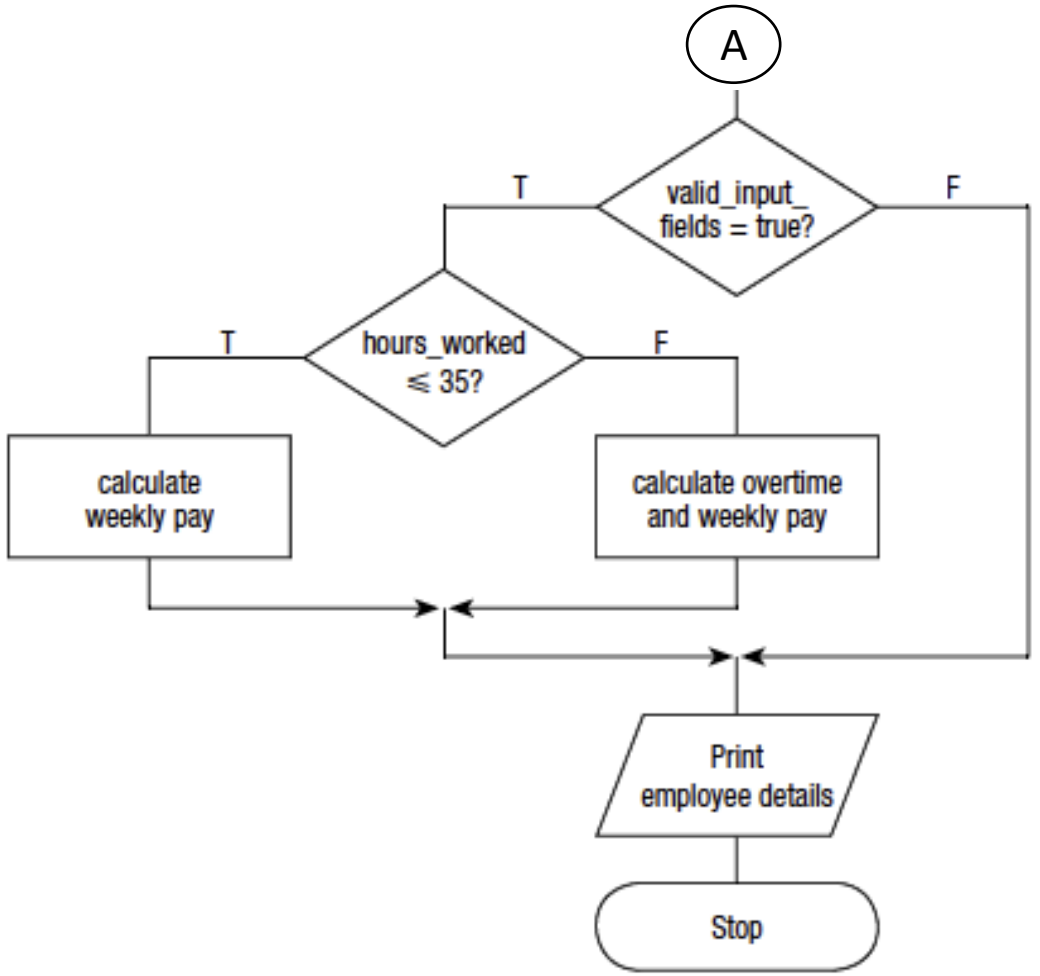
Weekly pay calculation: Weekly pay is calculated as hours worked times pay rate. If more than 35 hours are worked, payment for the overtime hours worked is calculated at time-and-a-half.

Example 3: Calculate employee's pay

Input	Processing	Output
emp_no pay_rate hrs_worked	Read employee details Validate input fields Calculate employee pay Print employee details	emp_no pay_rate hrs_worked emp_weekly_pay error_message

Example 3

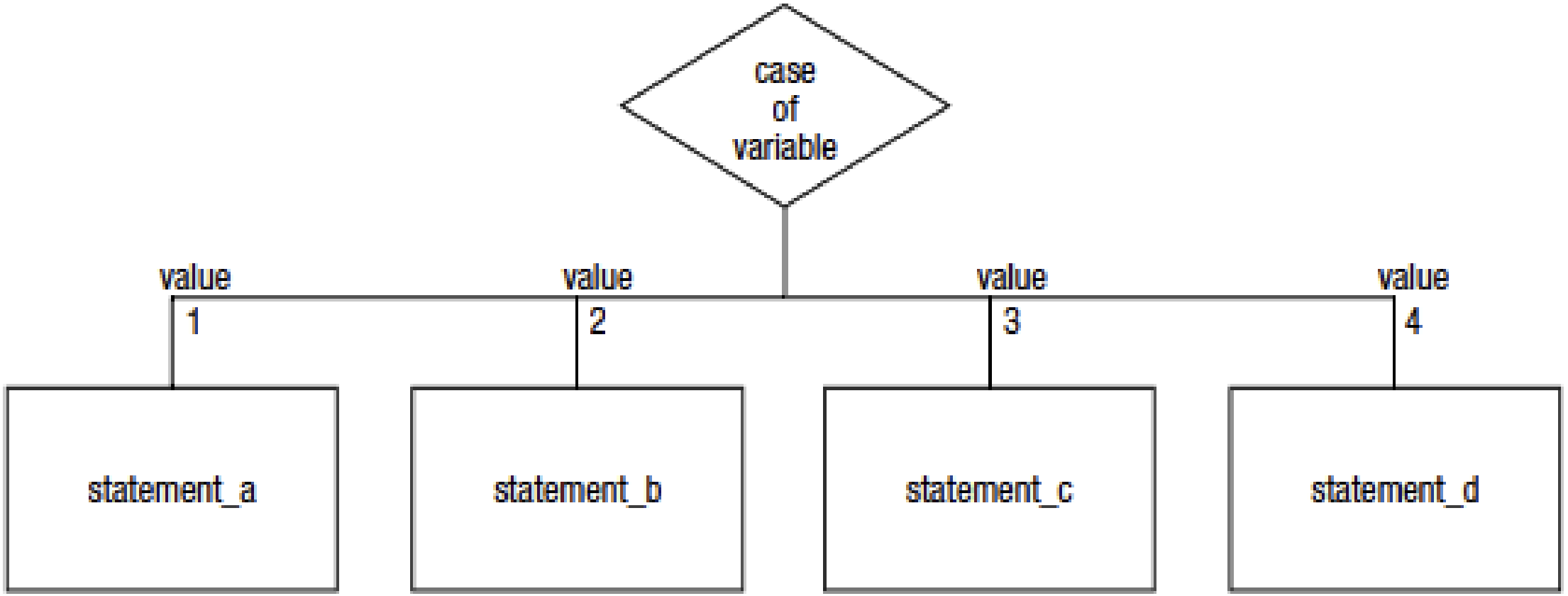

Start
valid_input_
fields = true
error_message
= blank
Read
employee details
pay_rate
> $25.00?
T
F
valid_input_fields
= false,
print error message
hrs_worked
> 60?
T
F
valid_input_fields
= false,
print error message
A


A
valid_input_
fields = true?
T
F
hours_worked
≤ 35?
T
F
calculate
weekly pay
calculate overtime
and weekly pay
Print
employee details
Stop

The Case Structure

- The case control structure is **another way** of expressing a nested IF statement.
- It is not really an additional control structure, but one that extends the basic selection control structure to be a choice between multiple values.
- It is expressed in a flowchart by a decision symbol with a number of paths leading from it, depending on the value of the variable.

The Case Structure



Example : Process customer record

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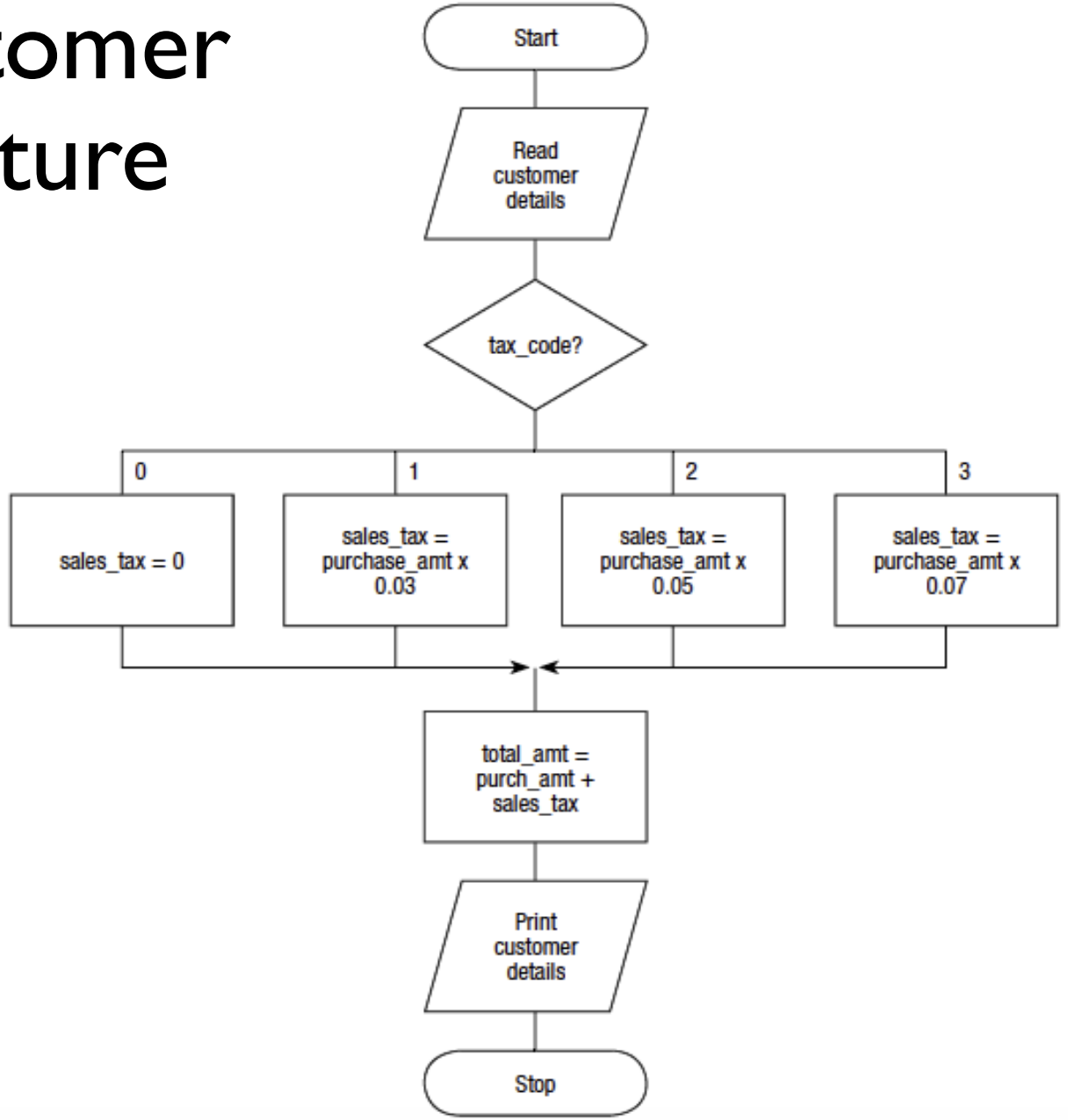
Example : Process customer record

Defining diagram

Input	Processing	Output
cust_name	Read customer details	cust_name
purch_amt	Compute sales tax	purch_amt
tax_code	Compute total amount	sales_tax
	Print customer details	total_amt

Example: Process customer record (In Case Structure Flowchart Diagram)



Practice 1

Design an algorithm **in flowchart** that will receive two integer items from a terminal operator, and display to the screen their sum, difference, product, and quotient. Note that the quotient calculation (first integer divided by second integer) is only to be performed if the second integer does not equal zero.

Practice 2

Design an algorithm **in flowchart** that will prompt an operator for a student's serial number and the student's exam score out of 100. Your program is then to match the exam score to a letter grade and print the grade to the screen. Calculate the letter grade as follows:

Exam score	Assigned grade
90 and above	A
80–89	B
70–79	C
60–69	D
below 60	F

Practice 3

Design an algorithm **in flowchart** that will prompt a terminal operator for the price of an article and a pricing code. Your program is then to calculate a discount rate according to the pricing code and print to the screen the original price of the article, the discount amount, and the new discounted price. Calculate the pricing code and accompanying discount amount as follows:

If the pricing code is Z, the words 'No discount' are to be printed on the screen. If the pricing code is not H, F, T, Q, or Z, the words 'Invalid pricing code' are to be printed.

Pricing code	Discount rate
H	50%
F	40%
T	33%
Q	25%
Z	0%

NEXT WEEK'S OUTLINE

1. Pseudocode with selection control structure
2. Desk checking
3. Exercises

REFERENCES

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3. Informatics study program slides, 2023, Fundamentals of Programming, Universitas Multimedia Nusantara.

Visi

Menjadi Program Studi Strata Satu Informatika **unggulan** yang menghasilkan lulusan **berwawasan internasional** yang **kompeten** di bidang Ilmu Komputer (*Computer Science*), **berjiwa wirausaha** dan **berbudi pekerti luhur**.

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3. Melaksanakan kegiatan pengabdian kepada masyarakat berbasis ilmu dan teknologi Informatika dalam rangka mengamalkan ilmu dan teknologi Informatika.