COMPUTER PROGRAMMING
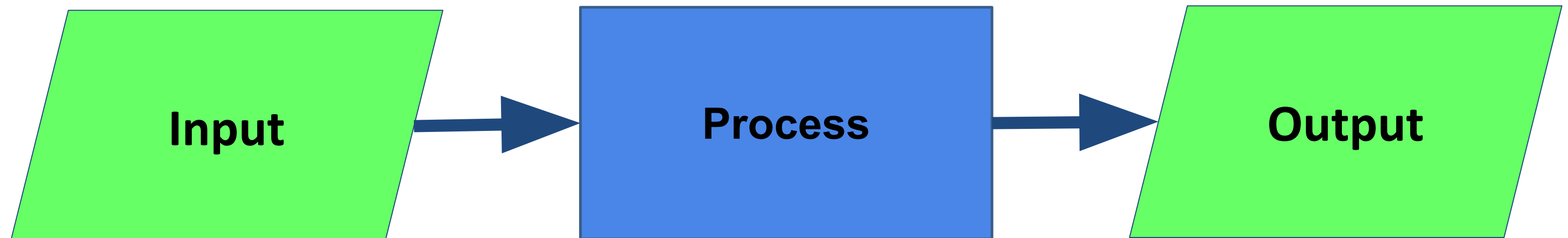
Topic 2: Problem Analysis

Learning Outcomes:

(a) Define the Input-Process-Output (IPO) model **(1 hour)**

RECAP :

❖ Problem analysis is the first step in problem solving process.

❖ Programmers use **input**, **process** and **output (IPO model)** to organize and summarize the results of the given problem.

IPO Model

The Input-Process-Output (IPO) Model is an approach to describe and visualize the input, process and output to solve the given problem.

Problem Analysis

Problem analysis is the activities of identifying

- **input**
- **process and/or condition (if any)**
- **output**

from the problem scenario.

Example of problem scenarios:

- **Find the area of a rectangle given width and height**
- **Find the area of a circle**
- **Calculate the sum of two numbers**

IPO Model Description

INPUT	PROCESS	OUTPUT
Input is the value entered/inserted by user	Process is the manipulation (arithmetic/ logical comparison) of input to produce output. Print is not a process.	Output is the expected result asked in the problem statement/ question.
Keywords: input, enter, read, get, from the problem statements	**Keywords**: calculate, compute, count, determine, find, check, compare, if, else, or, otherwise, repeat, times, while, loop, until, as long as from the problem statements	**Keywords** : display, print, show, convey, find from the problem statements
represented by a descriptive name (noun)	Represented by a verb that involves sequence, selection and repetition control structure process	represented by a descriptive name (noun) or message (" ")
Eg: name, number, price, width, height, weight	**Eg: calculate the sum of two numbers, calculate the area of a rectangle, determine the average mark based on two quizzes, repeat calculating total mark of 10 students**	**Eg: sum, total, area, average, "Pass", "Hello world"**

Steps to create IPO Model

1. Analyze the given problem

2. Determine the goal – <u>Output</u>

3. Determine the items needed to achieve that goal – <u>Input</u>

4. Determine activity that takes place to achieve the goal – <u>Process</u>

- Always **search** **<u>first</u>** for the **<u>Output</u>**.

Topic 2: Problem Analysis

Learning Outcomes:

(b) Identify input, process, and output in the given scenarios. **(1 hour)**
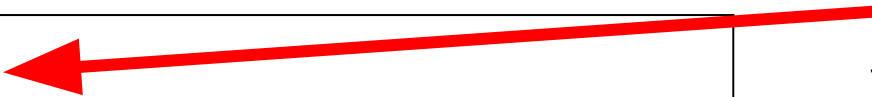
IPO Model

Calculate and display sum of three numbers.		
INPUT	PROCESS	OUTPUT
number1, number2, number3	Calculate Sum based on number1, number2 and number3 or Calculate Sum based on three numbers	Sum

Conclusion

Create an IPO model (*refer example below*)

Find the area of a rectangle given width and height		
INPUT	**PROCESS**	**OUTPUT**
width, height	Calculate area of rectangle based on width and height	area of rectangle

Problem statement

IPO chart / diagram

Topic 2: Problem Analysis

Learning Outcomes: **(1 hour)**

(d) Identify sequence control structure.

Topic 2: Problem Analysis

Control structure.

A control structure is a block of programming that analyzes variables and chooses a direction in which to go based on given parameters. It shows the logical order of program instructions.

In 1996, two researchers, C. Bohm, and G. Jacopini, demonstrated that any algorithm can be described using only three (3) control structures:

1. Sequence
2. Selection
3. Repetition

Topic 2: Problem Analysis

Sequence Control Structure Definition

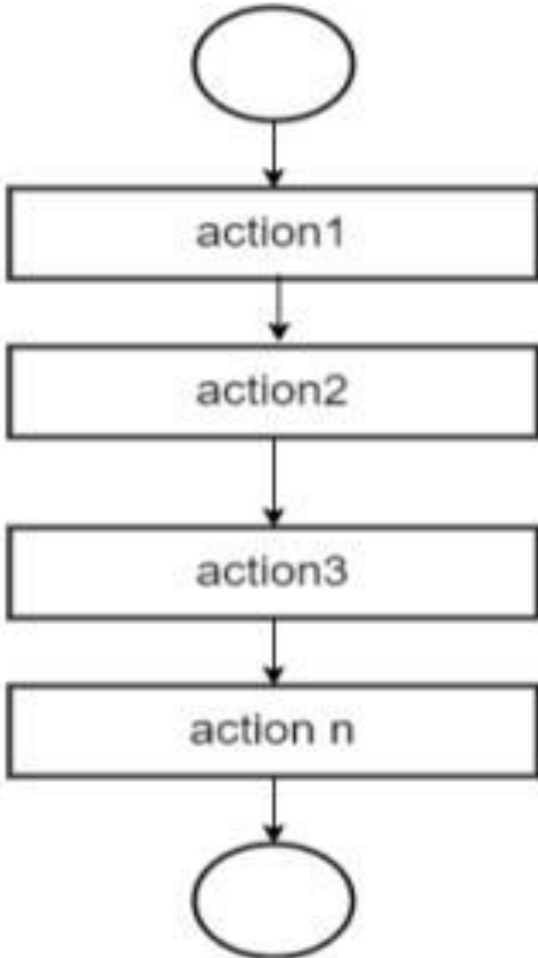A series of actions that are sequentially executed in the order they are written.

(example : Calculate sum of two numbers)

Topic 2: Problem Analysis

- A series of actions that are sequentially executed in the order they are written. (example: Calculate the sum of two numbers)

- A sequence control structure is a series of actions that are sequentially executed in the order they are written in an algorithm. (represented by rectangle shape)

- Performs statements one after another in sequence

- All actions will be executed sequentially, none will be skipped.

- Actions can be input, process, or output.

COMPUTER PROGRAMMING
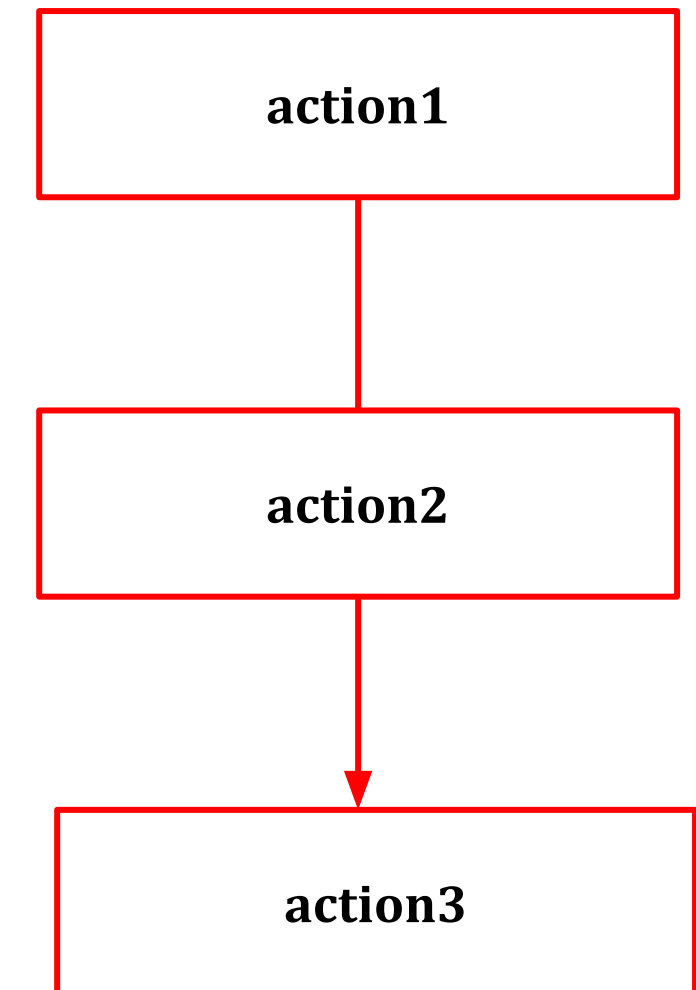
Topic 2: Problem Analysis

IPO Model *General Format*		*Pseudocode General Format*	*Flowchart General Format*
Input	List all required *input,* separated by **comma**	**Start** action1 action2 action3 … … … action n **Stop**	
Process	**Calculate** *output* based on *input* *Explanation of how to get output based on the **input** entered* *No formula in process*		
Output	List all *output,* separated by **comma**		

Topic 2: Problem Analysis

Example 1: The program will find the square of a given number.

Problem Analysis/ IPO Model
Input : *number* Process : Calculate *square* based on *number* Output : *square*

Topic 2: Problem Analysis

Example 2: Identify the input, process and output for the given problem statement.

The program will calculate average of 5 test marks

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Example 2: Identify the input, process and output for the given problem statement.

The program will calculate average of 5 test marks

Input   : test1, test2, test3, test4, test5

Process   : Calculate average based on test1, test2, test3, test4, test5

Output   : average

Topic 2: Problem Analysis

Exercise 1: Identify the input, process and output for the given problem statement.

Given the Koala Water Park entrance ticket rates as shown below:

Ticket price for adult   : RM 23.50

Ticket price for children   : RM 18.90

A program allows a user to key in the number of family members based on the criteria above, and then calculate the total ticket price for a family.

Topic 2: Problem Analysis

Exercise 2: Identify the input, process and output for the given problem statement.

The height based on arm span can be estimated by using the following equation:

Height = 0.87 × arm span + 20.54.

Estimate height from the arm span of a person.

Topic 2: Problem Analysis

Exercise 3: Identify the input, process and output for the given problem statement.

Given an airplane's acceleration a and take-off speed v, you can compute the minimum runway length needed for an airplane to take off using the following formula:

$$length = \frac{v^2}{2a}$$

A program prompts the user to enter v in meters/second (m/s) and the acceleration (a) in meters/second squared (m/s2) and displays the minimum runway length. Identify the type of control structure and IPO.

Here is a sample run:

```
Enter speed and acceleration: 60 3.5
The minimum runway length for this airplane is 514.286
```

Topic 2: Problem Analysis

Exercise 4: Identify the input, process and output for the given problem statement.

Mr Marqueen takes a car loan. The interest rate fixed by the bank is 4% per year, which means he has to pay the interest of 4% of the loan every year. He is allowed to pay the total of his loan plus the interest by monthly installment. Calculate the total amount that he has to pay to the bank and the monthly payment that he has to make.

COMPUTER PROGRAMMING

Topic 2: Problem Analysis (1 hour)

Learning Outcomes:

(f) identify selection control structure

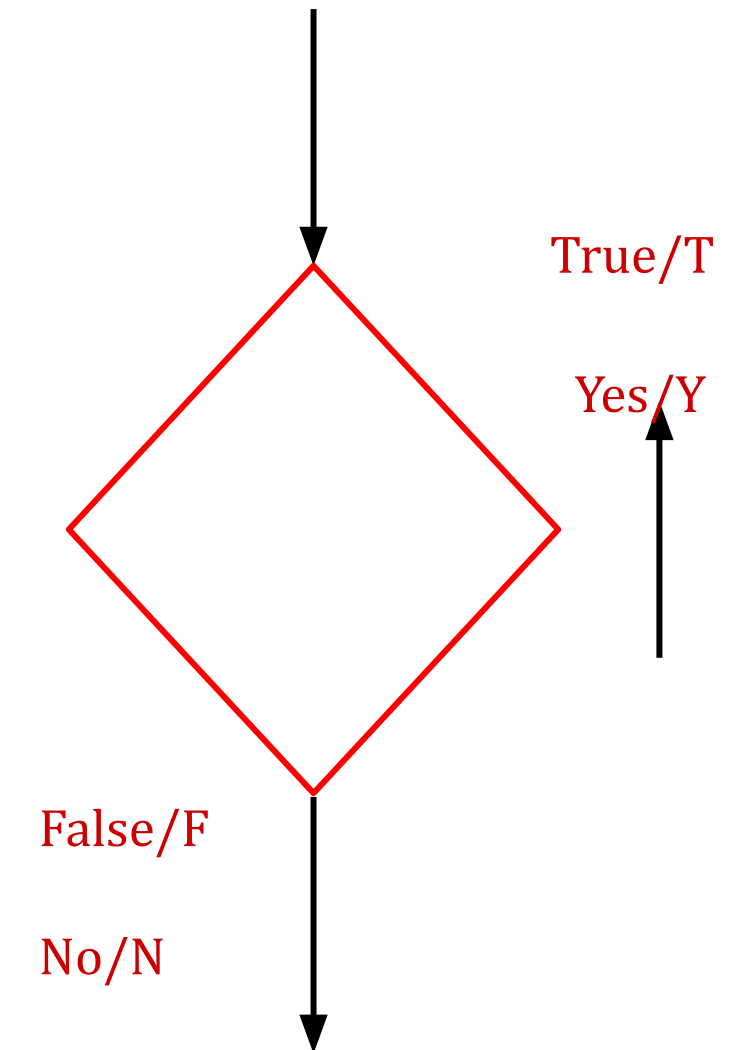## Topic 2: Problem Analysis

Selection Control Structure

Decide which statement(s) to execute based on a condition.

Defines two courses of action depending on the outcome of a condition.

(example : Print "Pass" or "Fail" based on grade entered)

Topic 2: Problem Analysis

- The selection control structure performs an action(s) based on a certain condition

- In pseudocode, selection will be represented using the **if** statement

- In the flowchart, the selection will be represented using decision symbol (represented by diamond shape)

True/T

Yes/Y

False/F

No/N

Topic 2: Problem Analysis

There are three (3) types of selection control structure:

1. Single Selection
2. Dual Selection
3. Multiple Selection

Topic 2: Problem Analysis

In **Single Selection**, the if statement performs an action if the specified condition (Boolean expression) is true. If the condition is false, nothing is done.
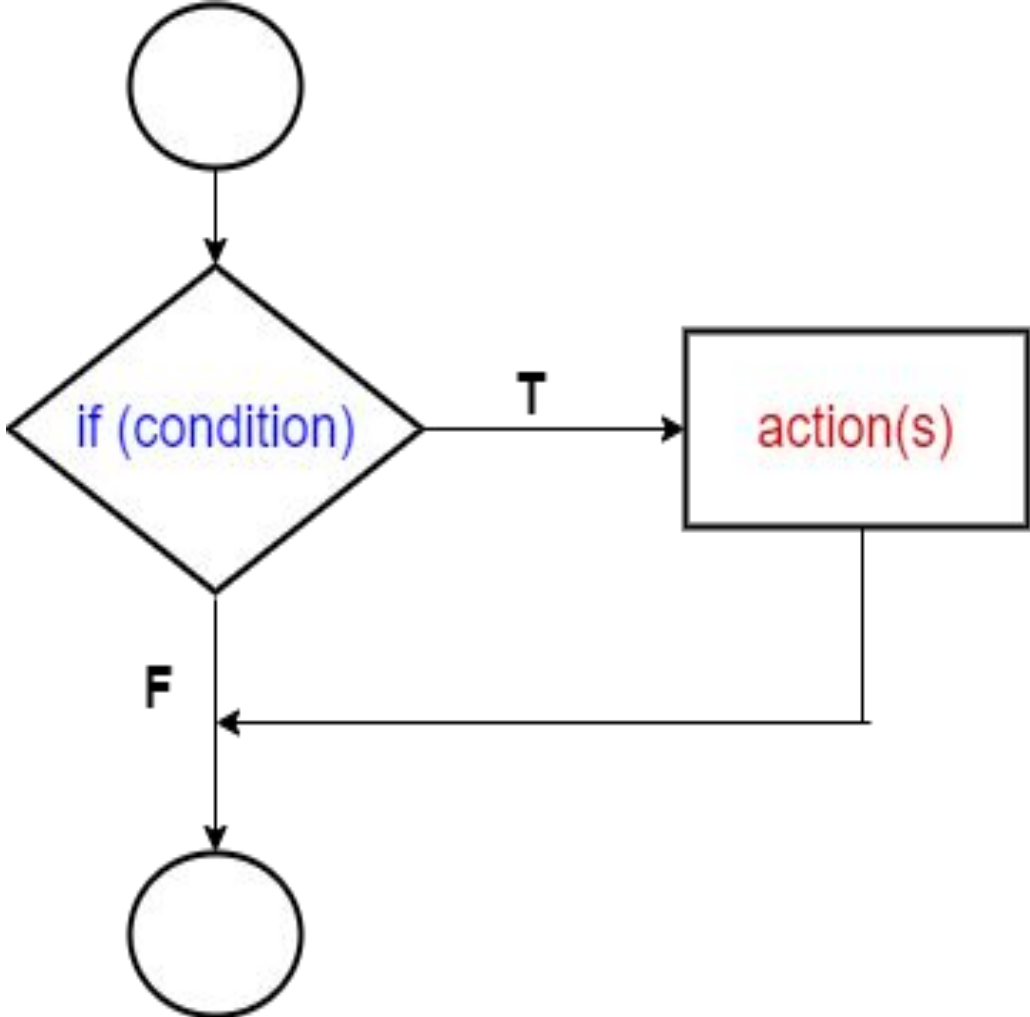
if statement :

Checks a condition to perform action(s)

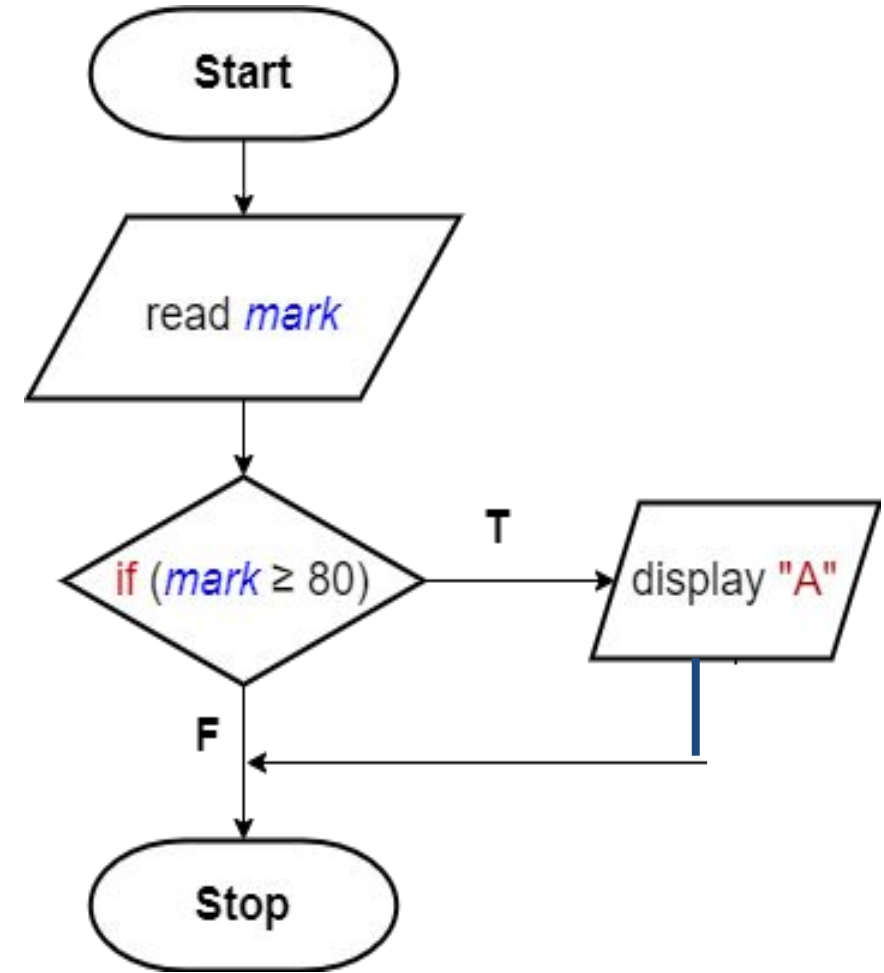If condition is True (T), perform actions(s)

If condition is False (F), skips it (i.e. perform nothing)

Topic 2: Input, Process, Output

IPO Analysis General Format		Pseudocode General Format	Flowchart General Format
Input	List all required *input,* separated by **comma**	**if** (condition) action(s) **end if**	
Process	**Determine** *output* based on *input* *Explanation of how to get output based on the **input** entered* *No formula in process*	*Note:* **end if** *used to indicate* **the end of an if block***.* *The* **condition** *(Boolean expression) must be written in bracket**( )**.*	
Output	*TrueOutput* **or** *no output*		

Topic 2: Problem Analysis

Example 1 : The program will display "A" if mark entered is greater or equal to 80

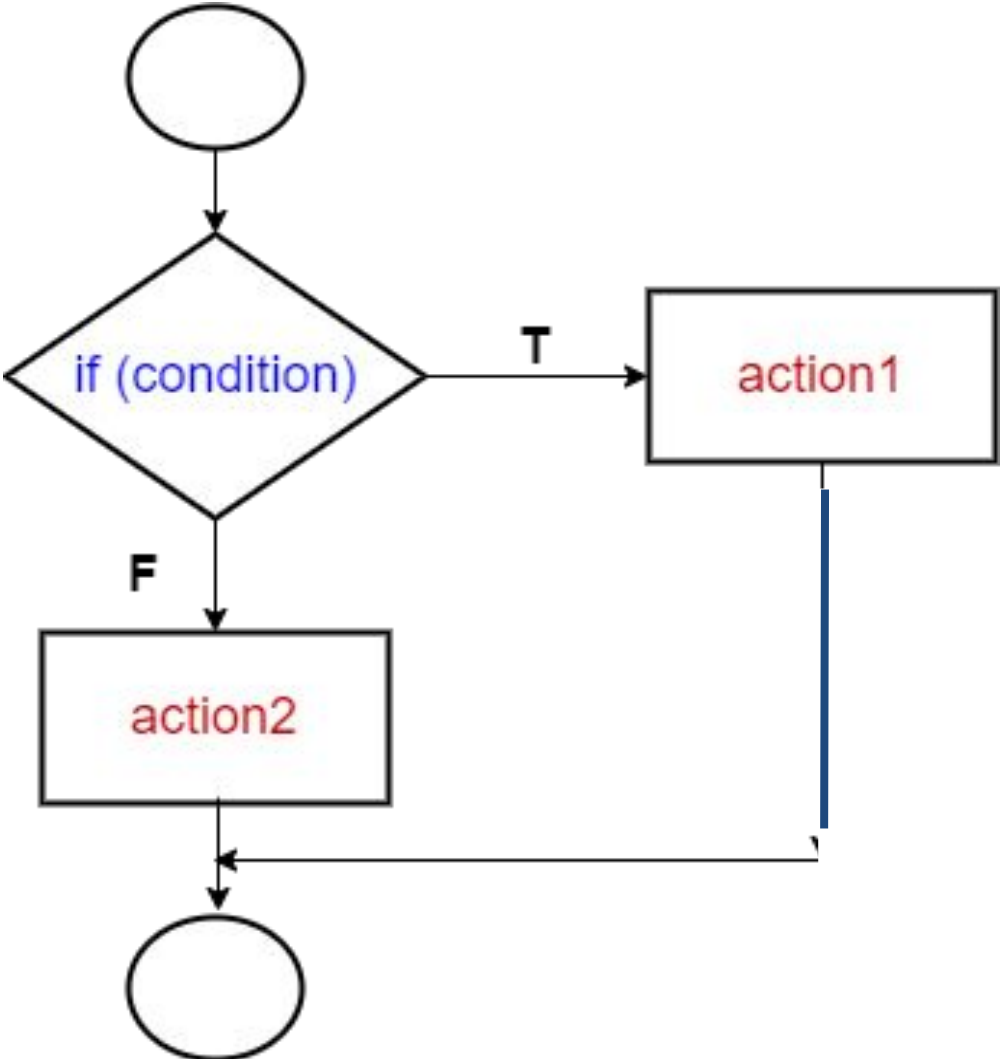| IPO Analysis	Example Pseudocode	Example Flowchart

Input : *mark*
 	
Process : Determine **"A"** *or no output* based on *mark*
 	
Output : **"A"** *or no output*
	Start
	   read *mark*
	  if (*mark* ≥ 80)
	     display "A"
	  end if
	Stop	

Topic 2: Problem Analysis

In **Dual Selection**, if the Boolean expression evaluates to true, the statement(s) for the true case is executed; otherwise, the statement(s) for the false case are executed instead.

if ... else statement :

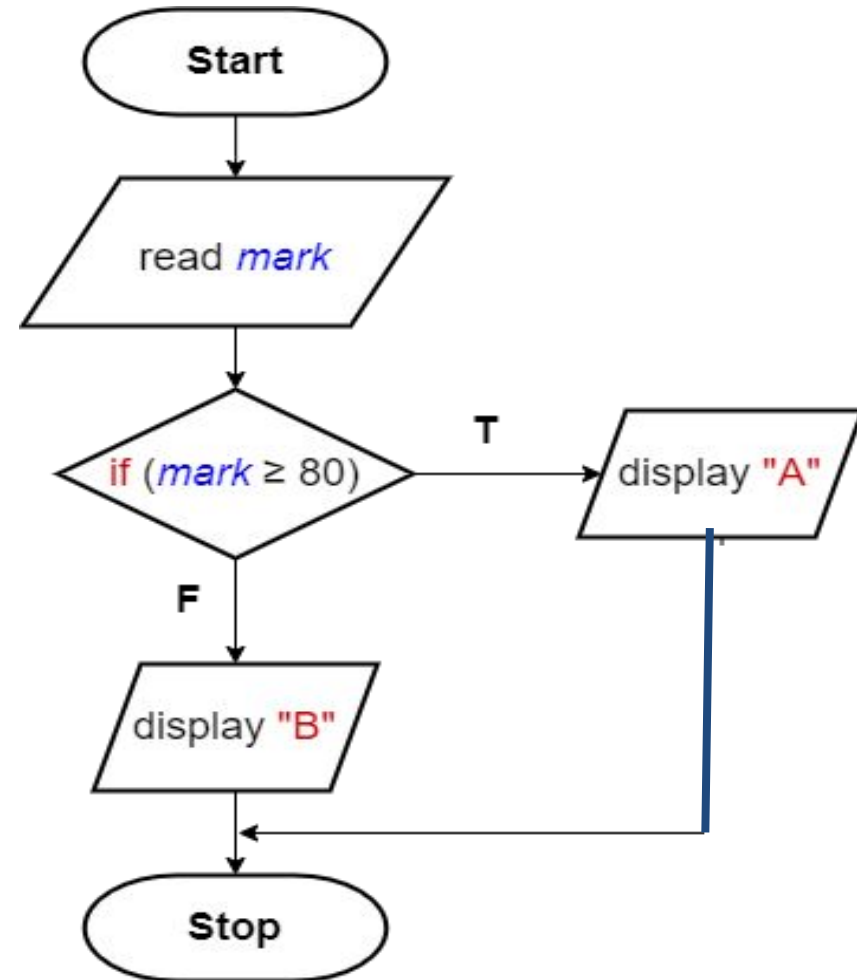Check one (1) condition to choose between two (2) actions
If the condition is True (T), perform action1, otherwise (if condition is False (F)), perform action2

Topic 2: Problem Analysis

IPO Analysis General Format		Pseudocode General Format	Flowchart General Format

Input	List all required *input,* separated by **comma**	**if** (condition)
		    action1
		else
		    action2
		end if
		
		Note : **end if** *is used to indicate the end of an if block. The condition (Boolean expression) must be written in bracket( ).*	

Process	**Determine** *TrueOutput or FalseOutput* based on *input* **No formula in process*		
Output	*TrueOutput **or** FalseOutput*		

COMPUTER PROGRAMMING

Topic 2: Problem Analysis

Example 2 : The program will display grade "A" if the mark entered is greater or equal to 80 or grade "B" if the mark entered is less than 80

IPO Analysis	Example Pseudocode	Example Flowchart

Input : *mark*
 	
Process : Determine **"A"** *or* **"B"** based on *mark*
or
Determine **grade** based on *mark*
 	
Output : **"A"** *or* **"B"**
	Start
	    read *mark*
	    if (*mark* ≥ 80)
	        display "A"
	    else
	        display "B"
	    end if
	Stop	

Topic 2: Problem Analysis

In **Multiple Selection**. conditions will be checked one by one, when a condition evaluates to true, perform the true case and stop checking the rest.

if ... else if...else statement :

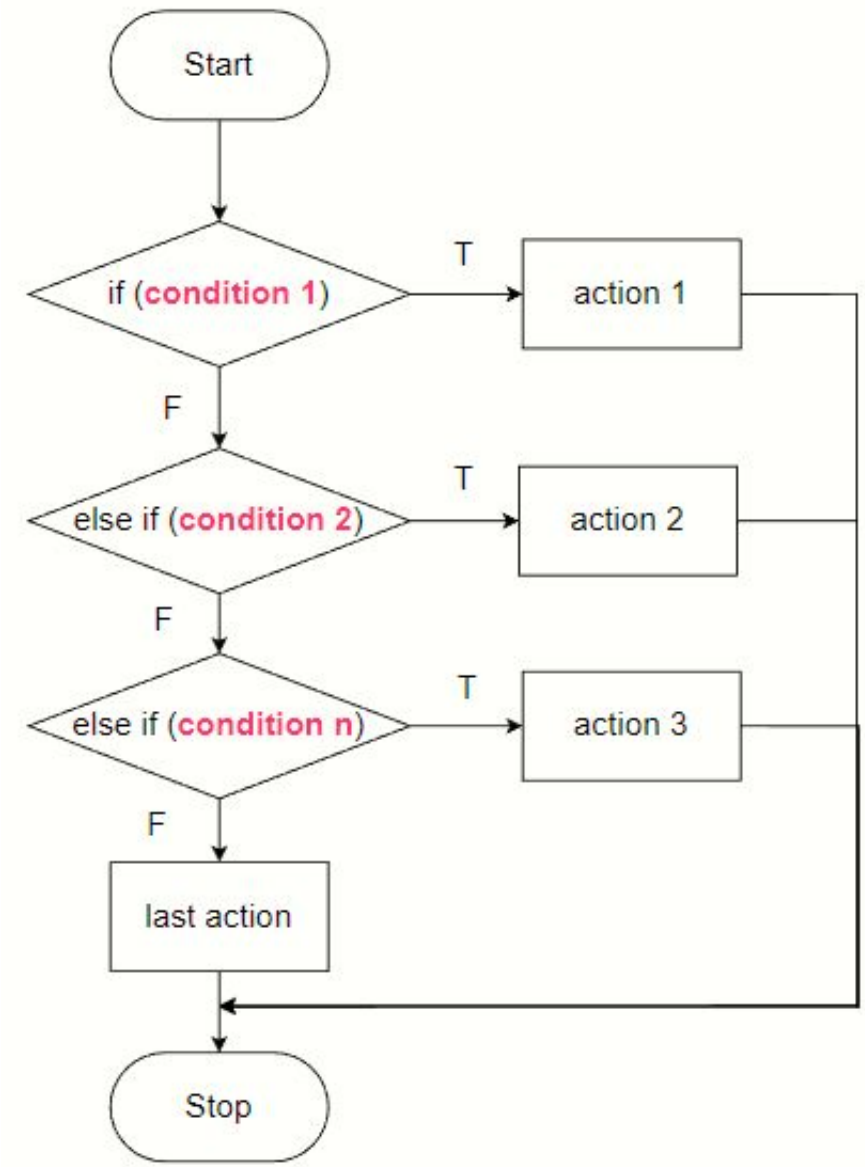Checks many conditions to choose between many actions

Condition will be checked one by one

When a condition is True, perform the action and stop checking the rest.

Note : exclude nested selection
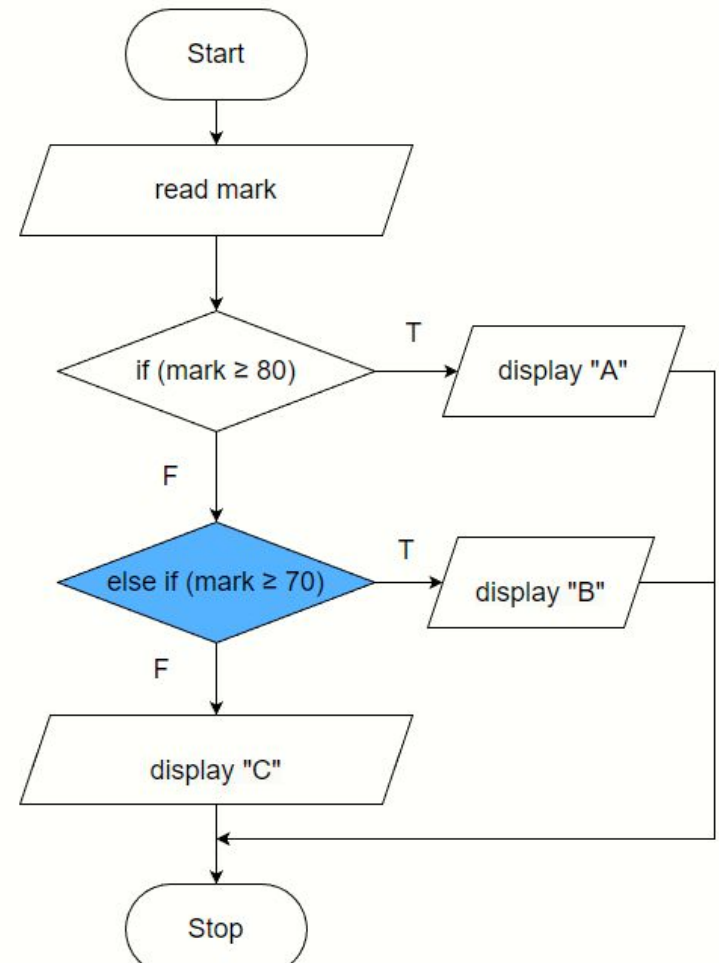
COMPUTER PROGRAMMING

Topic 2: Problem Analysis

IPO Analysis General Format		Pseudocode General Format	Flowchart General Format

Input	List all required *input,* separated by **comma**	**if** (condition1)
		    action1
		else if (condition2)
		    action2
		else if (condition n)
		    action n
		else
		    last action
		end if
		
		Note: end if used to indicate the end of an if block. The condition (Boolean expression) must be written in bracket( ).	

Process	**Determine** (write all possible *output)* based on *input* *No formula in process*		
Output	List all possible output, separated by the word or		

Topic 2: Problem Analysis

Example 3: The program will display grade "A" if mark entered is greater or equal to 80 or grade "B" if mark entered is in between 70 to 79 or grade "C" if mark entered is less than 70

IPO Analysis	Example Pseudocode	Example Flowchart

Input : *mark*
 	
 Process : Determine **"A" or "B" or "C"** based on *mark*
 or
 Determine **grade** based on *mark*
 	
 Output : **"A" or "B" or "C"**
	Start
	    read *mark*
	    if (*mark* ≥ 80)
	      display "A"
	    else if (*mark* ≥ 80)
	    display "B"
	    else
	      display "C"
	    end if
	 Stop	

Topic 2: Problem Analysis

Exercise 1: Identify the input, process and output for the given problem statement.

Print the message "You are entitled to vote" for a person whose age is above 18

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Exercise 2: Identify the input, process and output for the given problem statement.

A program will calculate age of a person's. If the age of the person is above 55, then the program will print "Retired", otherwise, the program will print "Still working".

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Exercise 3: Identify the input, process and output for the given problem statement.

The program will compare two numbers and display either message "num1 is greater than num2" or message "num2 is greater than num1"

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Exercise 4: Identify the input, process and output for the given problem statement.

User enters weight and height. Calculate BMI and print "Overweight" if BMI i> 25.0 or print "Normal" if BMI > 18, other wise print "Underweight" .

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Learning Outcomes:

(h) identify repetition control structure. **(1 hour)**

Repetition also known as looping, iteration

Topic 2: Problem Analysis

Specifies a block of one or more statements that are repeatedly executed until a condition is satisfied

2 types of repetition :

1. Counter-controlled (E.g: < 5)

2. Sentinel-controlled (A value that indicates the end of repetition process)

　　E.g- "Do you want to continue(Y/N)?"

In pseudocode, repetition will be represented using the keyword **while** in flowchart, the repetition structure will be controlled using decision symbol.

LECTURE NOTES

Topic 2: Problem Analysis (Approach 1)

In **Counter-Controlled Repetition**, the number of loops that need to be executed is known (either specified in the question or determined by the user), and it depends on the value specified in the condition.

IPO Analysis General Format	
Input	input for _____ times
Process	Repeat calculate output based on input for _____ times
Output	output for _____ times

Topic 2: Problem Analysis (Approach 2)

In **Counter-Controlled Repetition**, the number of loops that need to be executed is known (either specified in the question or determined by the user), and it depends on the value specified in the condition.

IPO Analysis General Format	
Input	input
Process	Repeat calculate *output* based on input for _____ times
Output	*output*

Topic 2: Problem Analysis (Approach 1)

Example 1 : The program calculate BMI for 5 persons

IPO Analysis
Input   : *weight*, *height* **for 5 times** Process : **Repeat calculate BMI based on** *weight* **and** *height* **for 5 times** Output   : **BMI for 5 times**

COMPUTER PROGRAMMING

Topic 2: Problem Analysis (Approach 2)

Example 1 : The program calculate BMI for 5 persons

IPO Analysis
Input   :   *weight*, *height*   Process :   **Repeat calculate BMI based on** *weight* **and** *height* **for 5 times**   Output   :   **BMI**

Topic 2: Problem Analysis

Sentinel-controlled repetition is sometimes called indefinite repetition because the number of loops to be executed is not known in advance.

It is a repetition procedure for solving a problem by using a sentinel value (also called a signal value, a dummy value or a flag value) to indicate "end of data entry".

LECTURE NOTES

Topic 2: Problem Analysis (Approach 1)

IPO Analysis General Format	
Input	**input for x times until _____**
Process	**Repeat calculate *output* based on input until _____**
Output	***output* for x times until _____**

Topic 2: Problem Analysis (Approach 2)

IPO Analysis General Format	
Input	**input**
Process	**Repeat** calculate *output* based on **input** until **_____**
Output	*output*

COMPUTER PROGRAMMING

Topic 2: Problem Analysis (Approach 1)

Example 2 : The program calculates BMI of persons and stops when the user enters 0.

IPO Analysis
Input   : *option*, *weight, height for x times until option equal to 0*   Process : **Repeat** calculate **BMI** for *x times* until option equal to 0   Output   : **BMI** for *x times* until option equal to 0

COMPUTER PROGRAMMING

Topic 2: Problem Analysis (Approach 2)

Example 2 : The program calculates BMI of persons and stops when the user enters 0.

IPO Analysis
Input   : *option*, *weight, height* Process : **Repeat** calculate **BMI** **based on weight and height** **until option equal to 0** Output   : **BMI**

Topic 2: Problem Analysis

Exercise 1 : The program will calculate sum and average of 5 numbers

Input   :

Process :

Output   :

Topic 2: Problem Analysis

Exercise 2: Program will calculate and print the average for a few numbers entered by user and terminate when 0 is entered

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Exercise 3: This program allows users to repeatedly enter numbers for 10 times. The program will only display numbers that are divisible by 5 and calculate its sum values.

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Exercise 4: Write a program that will calculate and print the age of 10 persons. If the age of the person is above 55, then the program will print "Retired", otherwise, the program will print "Still working".

Input   :

Process :

Output   :

Topic 2: Problem Analysis

Exercise 5: Write a program that reads a character until the character **q** is read. All characters, except **q** are counted and displayed.

Input   :

Process   :

Output   :

Topic 2: Problem Analysis

Identify the type of control structure based on the following statements.

Statement	Control Structure
i) Sam wants a program that displays the number of seconds it takes for a baseball to travel a specified distance at a specified speed.	
ii) Mr. Tan has a car rental business in Langkawi. Customers will pay a base fee according to the size of car rented. Small size (S) is RM50, medium size (M) is RM80 and large size (L) is RM100 per day.	
iii) The staff of HEP Unit need to find the total of module 1, module 2 and module 3 students who have attended the Local Rule Seminar. The program should also find the percentage of attendent for each module. The total of the participants are 100 students.	