EXPERIMENT NO. 3 (Group A)

Aim: Study of different GATES (AND, OR, XOR), Sensors and basic binary operations.

Outcome: To study different GATES (AND, OR, XOR), Sensors

- **Hardware Requirement:** Logical Gates,Sensors etc.

- **Software Requirement:** Raspbian OS

- **Theory:**

  A logic gate is a device that acts as a building block for digital circuits. They perform basic logical functions that are fundamental to digital circuits. Most electronic devices we use today will have some form of logic gates in them. For example, logic gates can be used in technologies such as smartphones, tablets or within memory devices.

  In a circuit, logic gates will make decisions based on a combination of digital signals coming from its inputs. Most logic gates have two inputs and one output. Logic gates are based on Boolean algebra. At any given moment, every terminal is in one of the two binary conditions, *false* or *true*. False represents 0, and true represents 1. Depending on the type of logic gate being used and the combination of inputs, the binary output will differ. A logic gate can be thought of like a light switch, wherein one position the output is off -- 0, and in another, it is on -- 1. Logic gates are commonly used in integrated circuits (IC).

- **Basic logic gates**

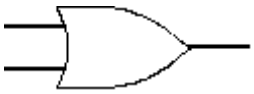
  There are seven basic logic gates: AND, OR, XOR, NOT, NAND, NOR, and XNOR.

- The *AND gate* is so named because, if 0 is called "false" and 1 is called "true," the gate acts in the same way as the logical "and" operator. The following illustration and table show the circuit symbol and logic combinations for an AND gate. (In the symbol, the input terminals are at left and the output terminal is at right.) The output is "true" when both inputs are "true." Otherwise, the output is "false." In other words, the output is 1 only when both inputs one AND two are 1.

AND gate

Input 1	Input 2	Output
	1	
1		
1	1	1

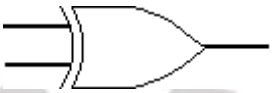
- The *OR gate* gets its name from the fact that it behaves after the fashion of the logical inclusive "or." The output is "true" if either or both of the inputs are "true." If both inputs are "false," then the output is "false." In other words, for the output to be 1, at least input one OR two must be 1.



OR gate

Input 1	Input 2	Output
	1	1
1		1
1	1	1

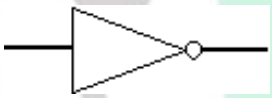
- The *XOR* (*exclusive-OR*) *gate* acts in the same way as the logical "either/or." The output is "true" if either, but not both, of the inputs are "true." The output is "false" if both inputs are "false" or if both inputs are "true." Another way of looking at this circuit is to observe that the output is 1 if the inputs are different, but 0 if the inputs are the same.



XOR gate

Input 1	Input 2	Output
	1	1
1		1
1	1	

- A logical *inverter*, sometimes called a *NOT gate* to differentiate it from other types of electronic inverter devices, has only one input. It reverses the logic state. If the input is 1, then the output is 0. If the input is 0, then the output is 1.



Inverter or NOT gate

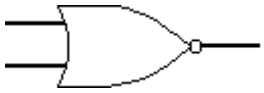
Input	Output
1	
	1

- The *NAND gate* operates as an AND gate followed by a NOT gate. It acts in the manner of the logical operation "and" followed by negation. The output is "false" if both inputs are "true." Otherwise, the output is "true."

NAND gate

Input 1	Input 2	Output
		1
	1	1
1		1
1	1	

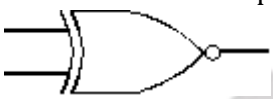
- The *NOR gate* is a combination OR gate followed by an inverter. Its output is "true" if both inputs are "false." Otherwise, the output is "false."



NOR gate

Input 1	Input 2	Output
		1
	1	
1		
1	1	

- The *XNOR (exclusive-NOR) gate* is a combination XOR gate followed by an inverter. Its output is "true" if the inputs are the same, and "false" if the inputs are different.



XNOR gate

Input 1	Input 2	Output
		1
	1	
1		
1	1	1

- Complex operations can be performed using combinations of these logic gates. In theory, there is no limit to the number of gates that can be arrayed together in a single device. But in practice, there is a limit to the number of gates that can be packed into a given physical space. Arrays of logic gates are found in digital ICs. As IC technology advances, the required physical volume for each individual logic gate decreases and digital devices of the same or smaller size become capable of performing ever-more-complicated operations at ever-increasing speeds.
- Composition of logic gates
- High or low binary conditions are represented by different voltage levels. The logic state of a terminal can, and generally does, often change as the circuit processes data. In most logic gates, the low state is approximately zero volts (0 V), while the high state is approximately five volts positive (+5 V).
- Logic gates can be made of resistors and transistors or diodes. A resistor can commonly be used as a pull-up or pull-down resistor. Pull-up and pull-down resistors are used when there are any unused logic gate inputs to connect to a logic level 1 or 0. This prevents any false switching of the gate. Pull-up resistors are connected to Vcc (+5V), and pull-down resistors are connected to ground (0 V).
- Commonly used logic gates are TTL and CMOS. TTL, or Transistor-Transistor Logic, ICs will use NPN and PNP type Bipolar Junction Transistors. CMOS, or Complementary Metal-Oxide-Silicon, ICs are constructed from MOSFET or JFET type Field Effect Transistors. TTL IC's may commonly be labeled as the 7400 series of chips, while CMOS ICs may often be marked as a 4000 series of chips.

- **Types of Sensors**

There are many different types of sensors. Here at Variohm, we offer a full range of sensors for industrial and commercial use.

Sensors are used throughout almost every industry for applications which we come into contact with on a daily basis as well as more industrial and specialist applications.

Sensors can be found in the home, the office, in our cars, buses, trains, trams, computers, medical facilities, labs, power plants, restaurants, food processing factories, production lines etc

A Sensor is used to take a measurement, the measurement will be processed and the result of the process, an output will be given. The output will then cause something to change or move. A simple example is the temperature sensor in a thermostat. The temperature sensor is constantly monitoring the temperature, once the measurement taken reaches the desired temperature, the measurement is processed and the output causes the boiler to switch off.

- **Types of Sensors**

There are many different types of sensors, the main categories are;

- Position Sensors
- Pressure Sensors
- Temperature Sensors
- Force Sensors
- Vibration Sensors
- Piezo Sensors
- Fluid Property Sensors
- Humidity Sensors
- Strain gauges
- Photo Optic Sensors
- Flow and Level Switches

These categories can all be split further into subcategories for example, within position sensors there are the following types;

- Contacting
- Non-contacting
- Rotary
- Linear

And these types of sensors can be split even further, within non-contacting you have the following types of sensors;

- Hall effect
- Capacitive
- Eddy Current

- Ultrasonic
- Laser
- Proximity

By splitting one category – Position Sensors it is clear to see that the number of sensors present in today's world is so vast that one blog post could not cover every type of sensor. However, here is an overview of different types of sensors Variohm can offer.

➢ **Types of Sensors – Position Sensors**

As discussed above there are many varieties of position sensor; linear, rotary, contacting, non-contacting and use a variety of different technologies. Position sensors are used to measure and monitor the position or displacement of an object.

We have been supplying position sensors for over 40 years and have developed our own range of position sensors which have been added to the comprehensive range from our suppliers and partners. Our own range includes;

Linear position Sensors

- VLP
- VXP
- ELPM
- VLPSC

Rotary Position Sensors

- Euro-X Hall Effect
- Euro-XP Puck – 2 part puck and magnet design
- Euro – XPD – D shaft
- CMRS
- CMRT
- CMRK

Further reading on Position Sensors

What is a Position Sensor?

Position Sensor Applications

➢ **Types of Sensors – Pressure Sensors**

Pressure sensors are often split into the following two categories; Pressure transducers and pressure switches. The main difference is that pressure transducers give accurate feedback on real-time pressure and pressure switches have a set limit which causes them to switch. Both pressure switches and pressure transducers have mechanisms which use the formula – Pressure = force divided by area to detect pressure.

Pressure sensors can measure the pressure in gases, liquids or solids and are used in a variety of industries. Underwater pressure transducers are referred to as level meters as the pressure they measure is directly related to the level of the water.

Pressure can be gauge, differential, absolute or vacuum and can be measured in Bar or PSI.

Many of our pressure sensors come from our trusted suppliers and we also have our own range of;

Pressure Transducers – EPT range

Pressure Switches - EPS range

Further reading on Pressure Sensors

Pressure Transducer Applications

What is a Pressure Sensor?

➢ **Types of Sensors – Load Cells and Force Sensors**

Load Cells are available in a wide variety of shapes and sizes. They are used to measure various types of force, the main one being weight. Load cells are used in all types of scales; from bathroom scales to counting scales, industrial scales, truck scales, hopper scales and everything in between.

Most load cells use internal strain gauges to monitor force based on the level of distortion on the strain gauge.
Our load cells come from our trusted suppliers. And can be seen on our website.
Further reading on Load Cells
Load Cells for Weighing
Load Cell Types and Applications

- **Types of Sensors – Temperature Sensors**

Temperature Sensors are another very common type of sensor – they are all around us. Temperature sensors are used to measure and monitor temperature, whether this is the main variable requiring measuring or a secondary variable which requires monitoring as a safety precaution within another application.

Different types of temperature sensors will require different approvals. Medical approvals will be required for temperatures used for patient monitoring or within medical devices. Other certifications will be required for temperature sensors in food and beverage applications.

Temperature sensors come in many different shapes sizes and types; thermistors, probes, thermocouples, RTDs and temperature transducers to name a few. Temperature Sensors is another type of sensor which we carry our own range of;

1. ETP – Eurosensor Temperature probes – these are fully customisable to your requirements.
2. Further reading on temperature sensors;
3. Temperature Sensor Applications
4. Types of Temperature Sensors

Conclusion: -

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Assignment Questions:

Q1. Enlist and explain different types of sensors?

Q2. Enlist and explain different types of Actuators?

Q3. What are sensors, and how do they work? Explain the difference between analog and digital sensors and provide examples of each.

Q4. Explain the working principle of AND, OR, and XOR gates. Provide truth tables for each gate and give an example of a circuit that uses each gate.