Laboratory 5: Digital circuits

Introduction and objectives

In this laboratory exercise you will use TTL (transistor-to-transistor logic) integrated circuits (ICs) to perform combinational and sequential logic functions. Specifically, you will learn how to use logic gates and flip flops. You will use components to build a simple circuit to control the display of an LED based on the past and current state of various switches or buttons.

The ICs you will be handling in this laboratory exercise require digital inputs and produce digital outputs. Each of the signals at the input and output terminals of a digital device can exist in only one of two possible states, a voltage low corresponding to binary zero, or a voltage high corresponding to a binary one. The ICs you will use in this laboratory exercise are TTL circuits. TTL devices process digital signals that have a high level defined from 3.5 to 5 V and low level between 0 to 0.7 V and 0.7 V to 3.5 V is a dead zone.

Components

7408 AND gate IC

This device contain four independent 2-input AND gates. Figure 1 below shows pin-out and schematic diagrams for the 7408.

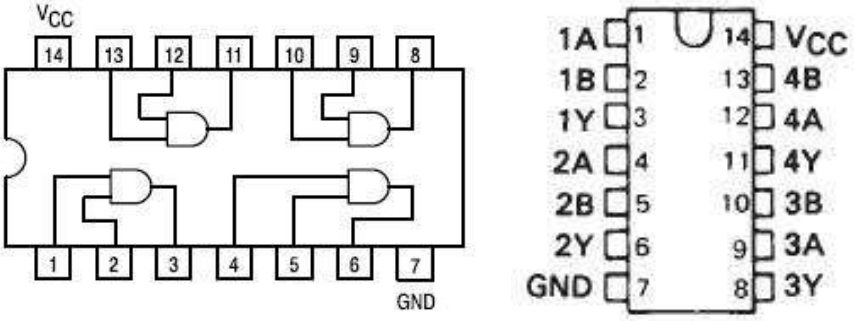
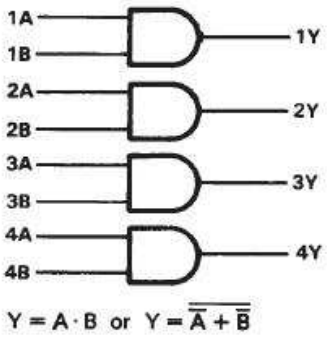


Figure 1: Pin-out and schematic diagrams for the 7408

Figure 2 below shows the logic diagram and function table for the 7408



FUNCTION TABLE (each gate)

INPUTS		OUTPUT
A	B	Y
H	H	H
L	X	L
X	L	L

Figure 2: Logic diagram and function table for 7408

7474 flip flop

IC 7474 is a dual D-type positive edge triggered flip flops with present and clear. This device contains two independent D-type positive edge triggered flip flops. Figure 3 below shows pin-out and schematic diagrams for the 7474.

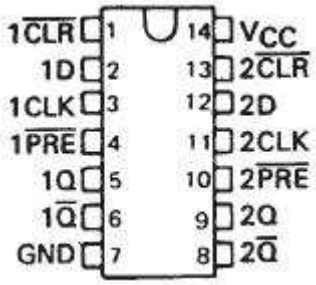
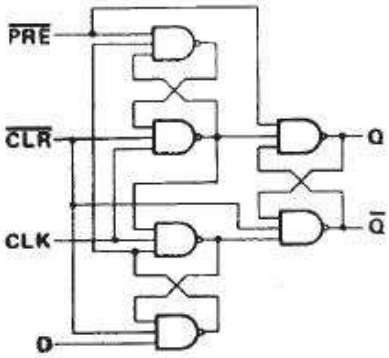


Figure 3: Pin-out diagram for the 7474

Figure 4 below shows the logic diagram and function table for the 7474.



FUNCTION TABLE

INPUTS				OUTPUTS	
$\overline{PRE}$	$\overline{CLR}$	CLK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H†	H†
H	H	↑	H	H	L
H	H	↑	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

Figure 4: Logic diagram and function table for 7474

Laboratory exercise

Figure 5 shows a 2-bit **data register** that uses positive edge triggered D flip flops to transfer data from two data lines to the outputs of two AND gates. It does this in two distinct steps. First, the data values D_i are transferred to the outputs Q of the flip flops on the positive edge of the load signal. Then a pulse on the read line presents the data at the register outputs R_i of the AND gates.

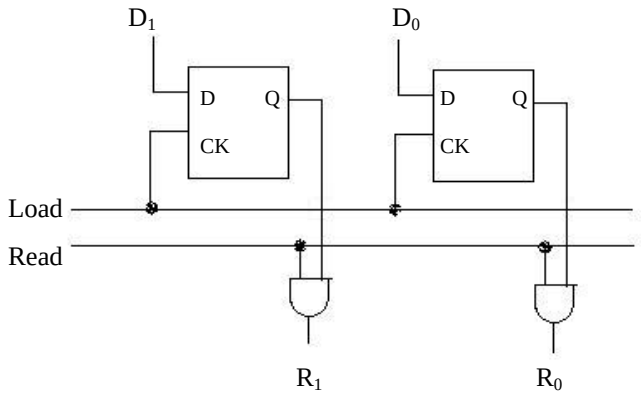


Figure 5: 2-bit data register

1. Using the pin-out diagrams, draw a complete, detailed wiring diagram for the circuit shown in Figure 5 using a 7408 AND gate IC and a 7474 positive edge triggered D flip flop. You will need to submit your detailed wiring diagram with your lab summary report.
2. Build the circuit shown in Fig. 5 and 6 and verify your results. Connect the transistor switch shown in Fig. 6 to the output R_1 and R_o of the data register.

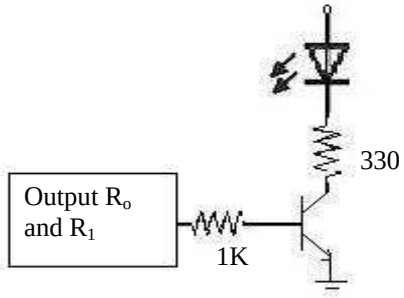


Figure 6: Circuit with 2-bit data register