Project Phase III: Digits of Pi — Conceptual Design Specification

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Description:

This project implements a digital logic circuit that outputs the first eleven digits of π based on a 4-bit binary input. The user enters a number from 0 to 10 using a 4-bit DIP switch, and the circuit generates the corresponding π digit using combinational logic. The design uses AND, OR, and NOT gates to implement the Boolean equations that produce each output bit. A set of four LEDs displays the resulting 4-bit binary digit, allowing the output to be easily verified during simulation and hardware testing. This specification includes the complete logic diagram, simulation results, and a parts list for the input/output components used in the design.

Logic Equations:

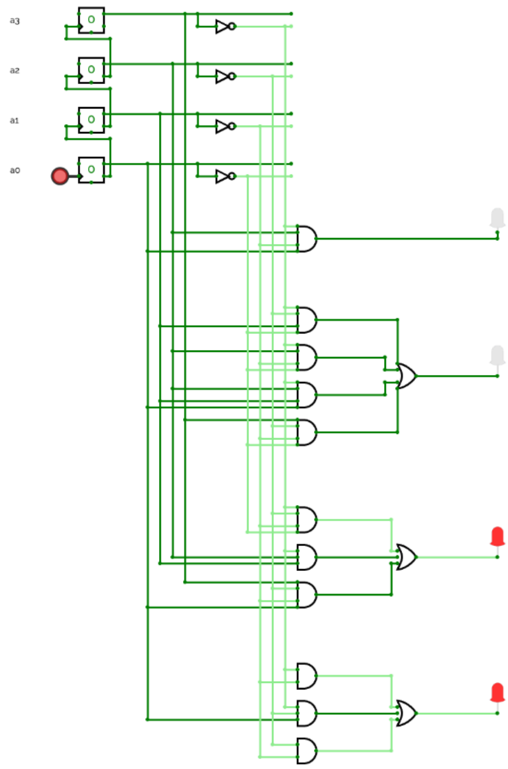
$O3 = \neg A3 \cdot A2 \cdot \neg A1 \cdot \neg A0$ → AND and NOT gates

$O2 = (\neg A3 \cdot A1) + (A3 \cdot \neg A2 \cdot A0)$ → AND, OR, and NOT gates

$O1 = (\neg A3 \cdot \neg A2 \cdot \neg A1 \cdot A0) + (\neg A3 \cdot A2 \cdot A1) + (A3 \cdot \neg A2 \cdot \neg A0)$ → multiple ANDs feeding into OR gates

$O0 = (\neg A3 \cdot \neg A2 \cdot A1 \cdot A0) + (\neg A3 \cdot A2 \cdot \neg A1 \cdot \neg A0) + (A3 \cdot \neg A2 \cdot \neg A0)$ → multiple ANDs feeding into OR gates

Circuit Simulation :



- **The circuit is correct** because the outputs it produces match the actual digits of π exactly (input/output simulations are below).

<u>Simulation Input:</u> Inputs that produced the outputs

A3	A2	A1	A0	Decimal Place	pi digit/digit	O3	O2	O1	O0
0	0	0	0	0	3	0	0	1	1
0	0	0	1	1	1	0	0	0	1
0	0	1	0	2	4	0	1	0	0
0	0	1	1	3	1	0	0	0	1
0	1	0	0	4	5	0	1	0	1
0	1	0	1	5	9	1	0	0	1
0	1	1	0	6	2	0	0	1	0
0	1	1	1	7	6	0	1	1	0
1	0	0	0	8	5	0	1	0	1
1	0	0	1	9	3	0	0	1	1
1	0	1	0	10	5	0	1	0	1

<u>Simulation Output:</u>

Binary = Decimal

- 0011 = 3
- 0001 = 1
- 0100 = 4
- 0001 = 1
- 0101 = 5
- 1001 = 9
- 0010 = 2
- 0110 = 6
- 0101 = 5
- 0011 = 3
- 0101 = 5

<u>Parts List:</u>

Input Devices

- **4-bit DIP Switch**
    - Only **1** required
    - Used to provide the 4-bit binary input (0000–1010) that selects which digit of π is output.

Output Devices

- **4 Individual LEDs**
    - Only **4** required
    - Used to display the 4-bit binary output value representing each digit of π.
    - Each LED corresponds to one output bit: **b3, b2, b1, b0**.
- **7-Segment Display (optional alternative)**
    - 1 required
    - Can replace the 4 LEDs to show decimal digits directly.

<u>Logic Components:</u>

- **NOT Gates (Inverters)**
    - Approx. **4** required
    - Used to generate the complement of each input bit (a3’, a2’, a1’, a0’).
- **AND Gates**
    - Approx. **12–16** required

- Used to form the minterms that define the binary outputs for each π digit.

- **OR Gates**
  - Approx. **4** required
  - One OR gate per output bit to combine terms that produce a “1”.

Connections:

- **Jumper Wires**
  - Multiple required (typically **25–40**)
  - The exact number varies based on breadboard arrangement.
- **Breadboard**
  - 1 required
- **5V Power Module / Power Supply**
  - 1 required
  - Standard for powering logic gates and LEDs in lab circuits.