Switching Circuits Laboratory (CS29002)

Assignment 1 (07+14-01-2025)

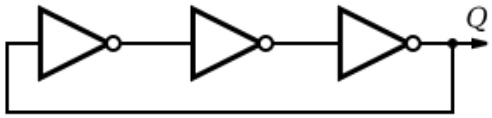
a) Realize an inverter (NOT gate) using the CMOS IC chip 4007. This chip provides three nMOS and three pMOS transistors.

Study the inverter's transfer characteristics by varying the input voltage in 0.5V steps and measuring both the input and output voltages on a Digital Storage Oscilloscope (DSO). You may have to increase the measurement resolution (e.g., in steps of 0.1V) at the transition zone of the curve. Plot the readings and determine the high and low noise margins for the gate.

b) Realize a 3-input CMOS NAND gate using three nMOS and three pMOS pairs of transistors in the IC chip 4007. Verify the truth table.

Realize a 3-input CMOS NOR gate using three nMOS and three pMOS pairs of transistors in the IC chip 4007. Verify the truth table.

c) Design a ring oscillator by cascading an odd number *N* of TTL NOT gates (use 7404 IC) in series with feedback as shown in the diagram below. Estimate the propagation delay of one NOT gate by measuring the frequency of the generated waveform on the DSO. Perform the experiment for *N* = 3 and *N* = 5.



Repeat the experiment with CMOS NOT gates, using a CMOS NOT gate chip (4069).

d) Implement a 4-bit (i) binary to Gray code converter, and (ii) Gray code to binary converter, using the TTL exclusive-OR IC 7486. Apply the inputs using on-board switches, observe the outputs on on-board LEDs, and verify the truth table.

Instructions:

1) *For each design, draw the circuit diagram on paper, following the conventions as suggested. Following this, you can issue the components and start with the realization on the breadboard.*
2) *After you finish each part of the experiment, show it to your assigned TA, who will be doing the evaluation.*
3) *You are expected to bring a wire cutter and a twizzer to the lab. Special credit will be given for neatly completed circuit realizations.*
4) *You must prepare a laboratory report for each experiment in PDF format and upload it to Moodle by the specified deadlines. A single report has to be uploaded per group.*