

FF ASSIGNMENT — SOLUTION KEY

Total Points: 25 | Questions: 5 | Date: February 19, 2026

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AI-generated undergraduate-level electrical assignment. Contains 5 questions covering key concepts.

Question 1

5.0 points

Examine the circuit shown below, which consists of two D flip-flops, FF1 and FF2, and a combinational logic that performs the AND operation on the outputs of these flip-flops. The inputs to the flip-flops are connected such that the D input of FF1 is '1' and the D input of FF2 is connected to the Q output of FF1. What will be the output waveform of the circuit for the first five clock cycles if the initial states are $Q_1=0$ and $Q_2=0$?

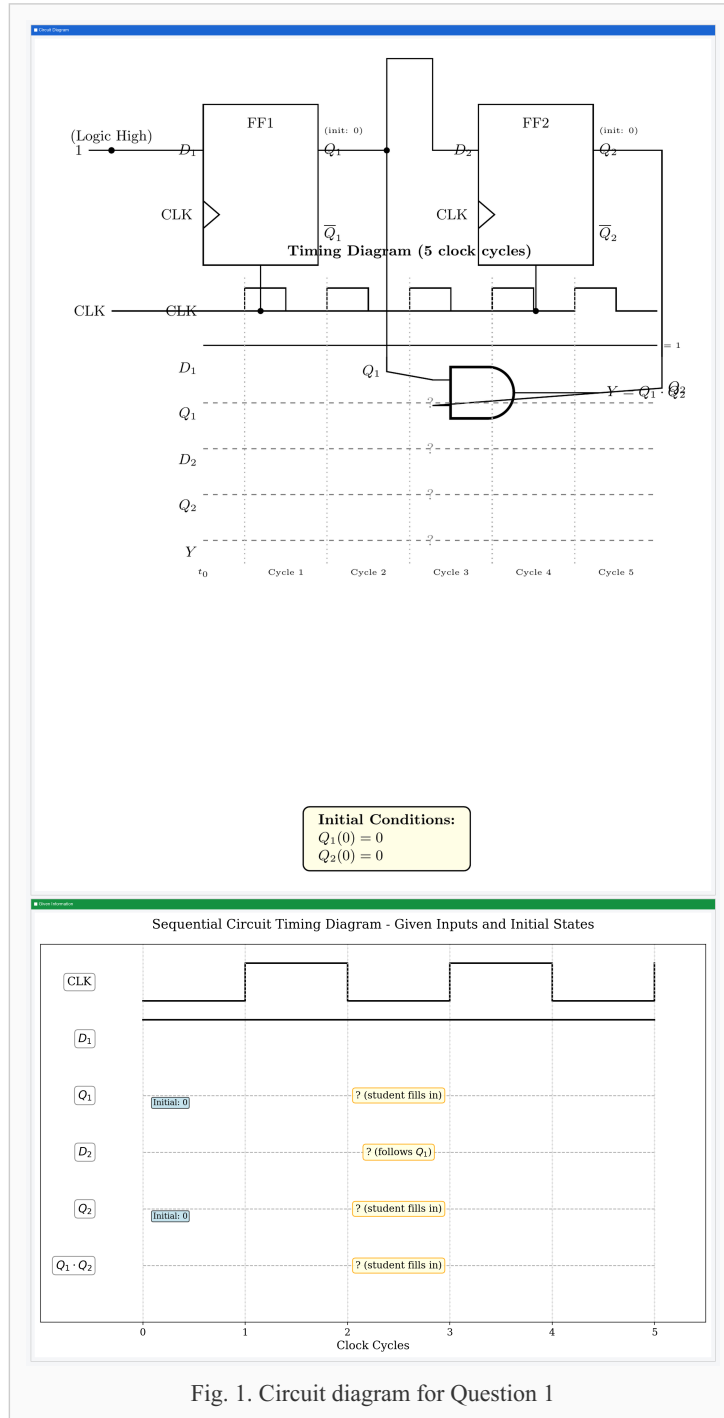


Fig. 1. Circuit diagram for Question 1

- A. 00, 10, 11, 11, 11
- B. 10, 11, 11, 11, 11
- C. 00, 01, 11, 11, 11
- D. 01, 10, 11, 11, 11

ANSWER

2

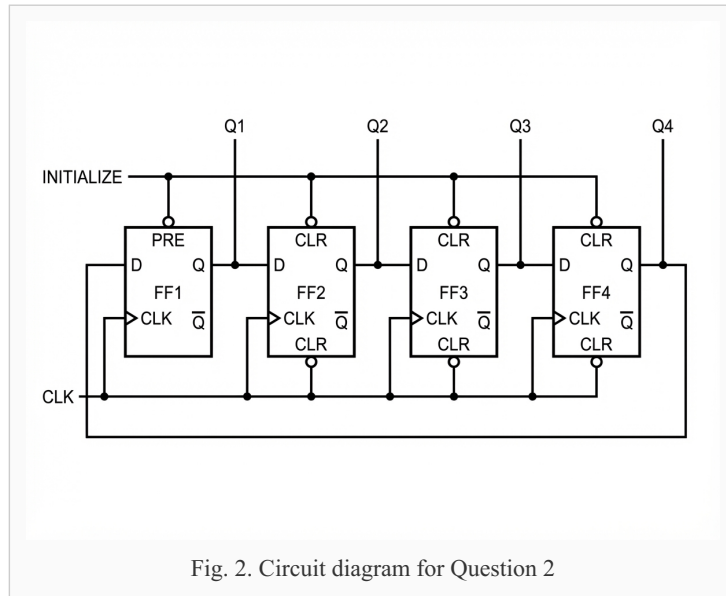
GRADING RUBRIC

For each clock cycle, evaluate the state of the outputs based on flip-flop inputs and previous states. Correct sequence is *00, 01, 11, 11, 11* as FF2 is driven by FF1.

Question 2

5.0 points

Explain how the ring counter with 4 flip-flops in the circuit shown below operates, and determine the sequence of outputs starting from an initial state of 1000 over 8 clock cycles.



ANSWER

The ring counter will cycle through the states *1000, 0100, 0010, 0001, 1000, 0100, 0010, 0001*, repeating every 4 cycles.

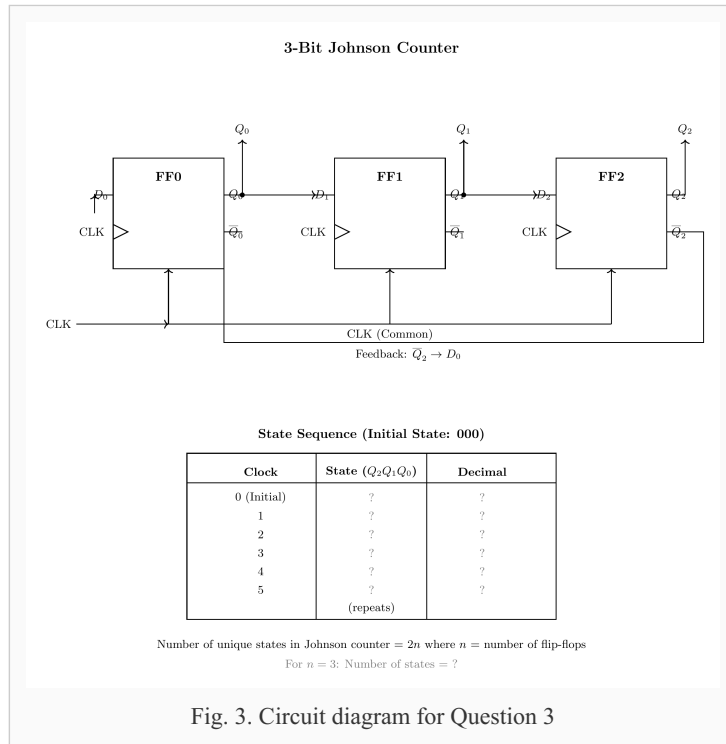
GRADING RUBRIC

Provide a clear explanation of the shift operation in a ring counter and how the bits are cycled through. Check the correctness of state sequence.

Question 3

5.0 points

Calculate the number of unique states in the Johnson counter using 3 flip-flops in the circuit shown below, and provide the state sequence starting from an initial state of 000.



ANSWER

The Johnson counter with 3 flip-flops has 6 unique states: *000, 100, 110, 111, 011, 001*.

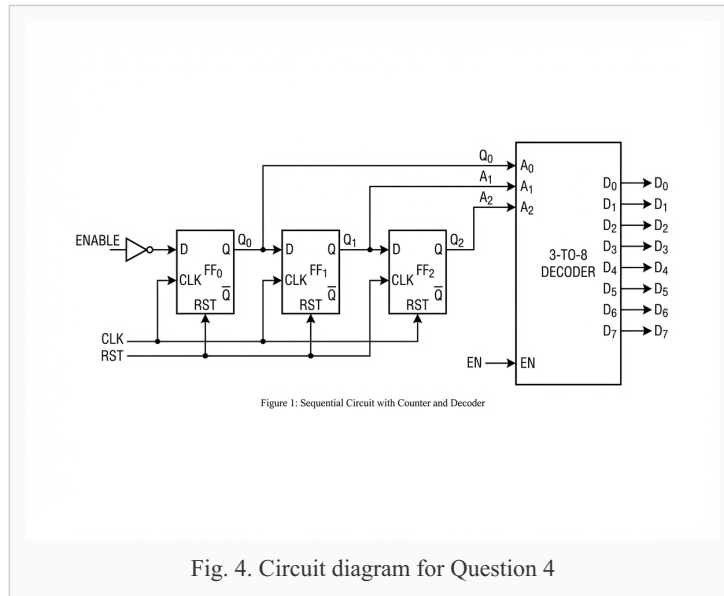
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Explain the operation of a Johnson counter with feedback and calculate unique states. Verify state transitions.

Question 4

5.0 points

Describe the function of a decoder in the sequential circuit shown below and how it can be used in conjunction with a counter to extend the state sequence.

**ANSWER**

A decoder translates a binary input into a unique active output. When combined with a counter, it can activate sequences for each counter state, effectively extending the possible sequences by associating actions or processes with each state.

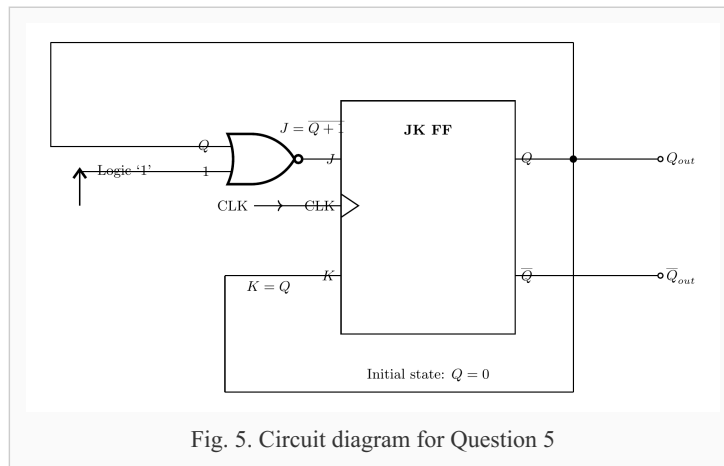
GRADING RUBRIC

Discuss the role of a decoder, its operation, and its effect on state sequence extension in sequential circuits. Provide examples for clarity.

Question 5

5.0 points

Consider the circuit shown below consisting of a JK flip-flop and a combinational logic circuit that implements a NOR gate. If Q and a constant '1' are inputs to the NOR gate, and the JK flip-flop is configured with $J=Q$ and $K=Q$, how will the output of the flip-flop change with each clock cycle, starting from an initial state $Q=0$?



- A. Toggle on each clock cycle.
- B. Remain in initial state.
- C. Toggle every two clock cycles.
- D. Output a constant zero.

ANSWER

0

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Analyze the operation of the JK flip-flop and NOR gate combination. Logical correctness of toggling behavior completes the answer.