King Mongkut's University of Technology Thonburi

Final Examination

Semester 1, Academic Year: 2015

CPE 223 Digital System Design

For Automation Engineering Students (2nd Year, International Program)

Date: Friday 27 November 2015   Time: 13.00 – 16.00

Instructions

1. The examination paper consists of 7 pages (this front page inclusive) and there are 6 questions with 10 points each. You must show all your work step-by-step.

2. Material, text books, dictionary, and computer are **not** allowed in the examination room.

3. Calculator is **not** allowed.

4. Student must complete the student name and I.D in every page.

Warning *Cheating is a serious misconduct! Stiff penalty will be imposed to a cheater.*

Asst.Prof.Dr. Pichitpong Soontornpipit

Examiner

This examination paper has been approved by the Department of Control System and Instrumentation

Engineering.

(Asst.Prof.Dr.Diew Koolpiruck)

Head of Department

1. (10 points) Design a combinationlogic circuit that operates an alarm in a car whenever the driver and/or passenger seat are occupied and the seat belts are not fastened when the car is started.The active-HIGH signals *DRIV* and *PASS* indicate the presence of the driver and passenger, respectively, and are taken from pressure-actuated switches in the seats. The signal *IGN* is active-HIGH when the ignition switch is on. The signal $\overline{BELTD}$ is active-LOW and indicates that the driver's seat belt is unfastened; the signal $\overline{BELTP}$ is the corresponding signal for the passenger seat belt. The alarm will be active (LOW) whenever the car is started and either of the front seats is occupied or its seat belt is not fastened.

2. (10 points) Determine the Q waveform for the FF where initially **Q** is 0.
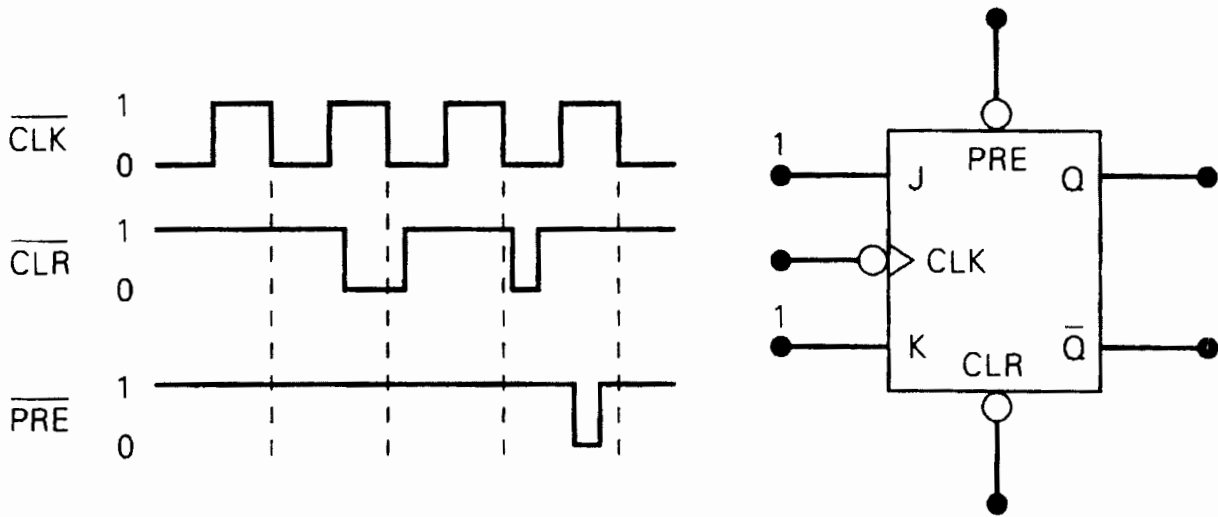
Figure for Problem 2.

3. (10 points) From the circuit below, initially all FFs are in the 0 state. The circuit operation begins with a momentary start pulse applied to the $\overline{PRESET}$ inputs of FFs **X** and **Y**. Determine the waveforms at **A, B, C, X, Y, Z** and **W** for 20 cycles of the clock pulses after the start pulse. State all assumptions.
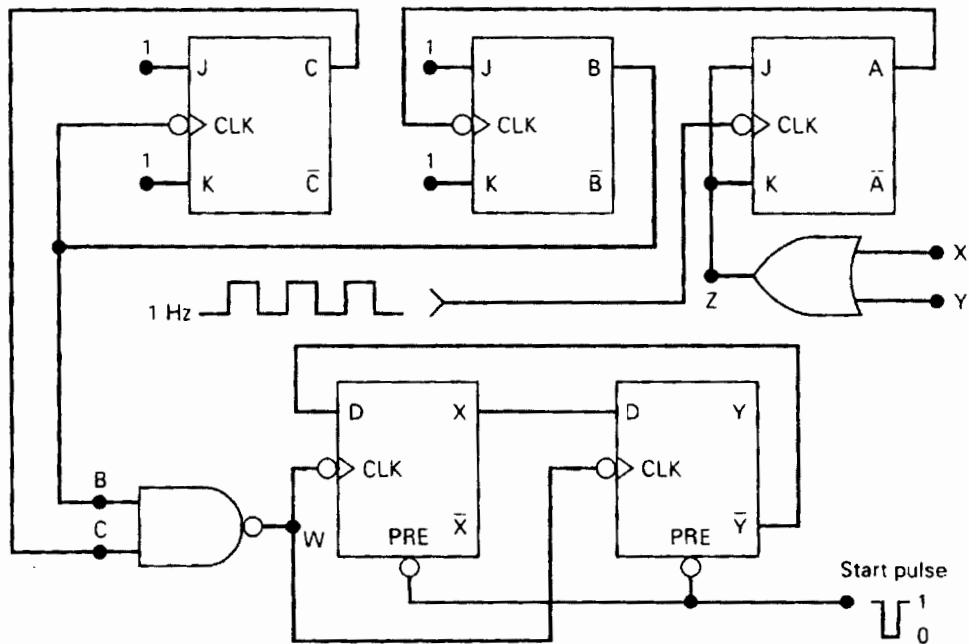

Figure for Problem 3.

4. (10 points) Design a circuit using JK FF for the stepper motor that rotates in steps rather than in a continuous motion. Magnetic coils within the motor are energized and deenergized in a specific sequence in order to produce this stepping action (coils 1 and 2 must always be in opposition states, and likewise coils and 4). When $D = 0$ the motor rotate clock-wise (CW) in the BA sequences of 11, 10, 00, 01, 11, 10, ..., and so on. On the other hand, for counter clock-wise (CCW), $D = 1$ and the counter (BA) follows the sequences 11, 01, 00, 10, 11, 01, ..., and so on.
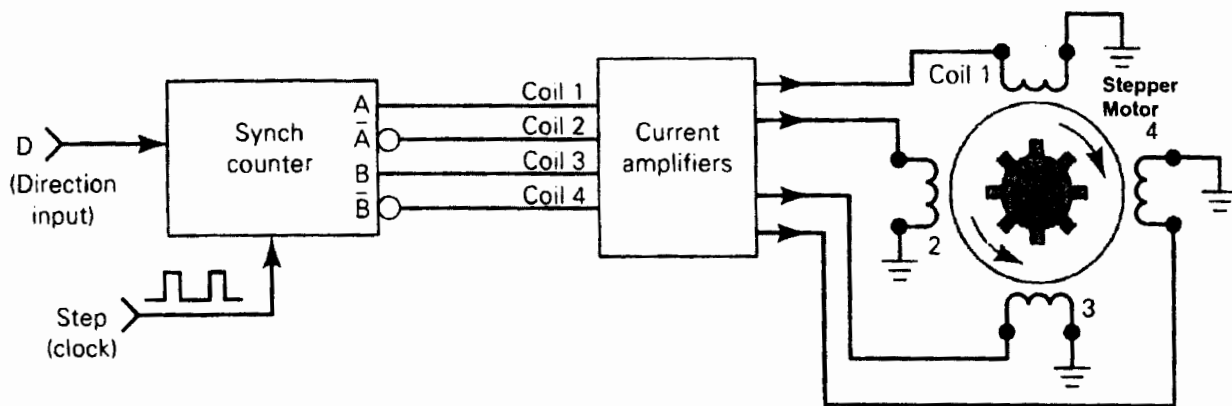

Figure for Problem 4.

5. (10 points)A sequential circuit has three flip-flops A, B, C; the input x and the output y. The state diagram is shown as the figure below. The circuit is designed by treating the unused states as don't-care conditions. Analyze the circuit obtained from the design to determine the effect of the unused statesusing D flip-flops in the design.
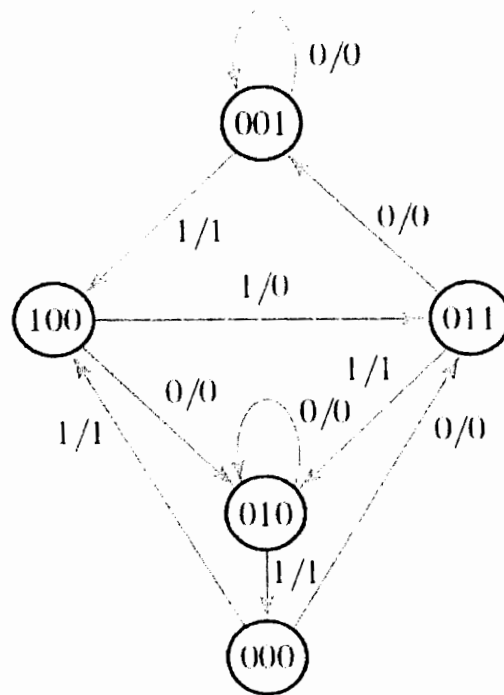

Figure for Problem 5.

6. (10 points) Design a synchronous MOD-12 counter (count-down) where each FF is clocked by the NGT of the clock input signal so that all FF transition occur at the same time.

   (a) Use T flip-flop

   (b) Use J-K flip-flop