Digital Electronics

Final Examination

Part C

College Credit Performance

Spring 2009

PRACTICE EXAM

Student Name: _____

Date: _____

Class Period: _____

Total Points: _____ /80

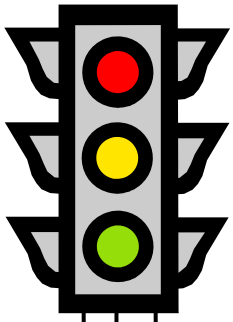
Converted Score: _____ / 50

Design Problem

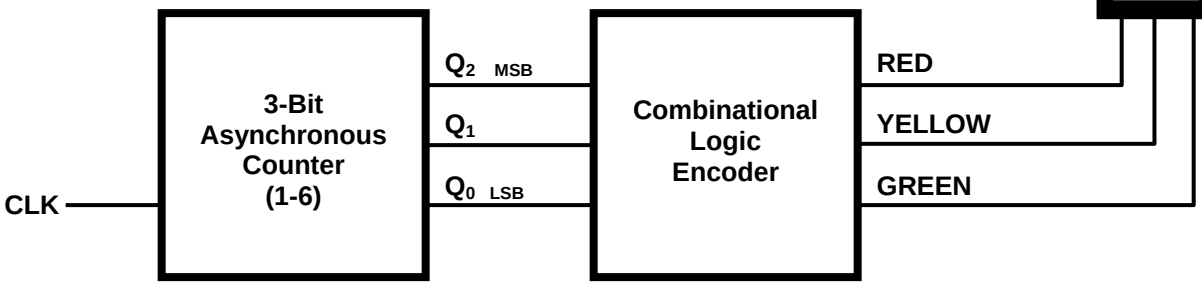
80 Points – Show ALL Work – Partial Credit May Be Awarded.

The diagram shown below is for a very simple *Traffic Light Controller* that has the lights cycle through GREEN – YELLOW – RED continuously. The design is made of two sub-systems that work as follows:

- The *3-Bit Asynchronous Counter* that continuously counts from 1 (Q_2=0, Q_1=0, Q_0=1) to 6 (Q_2=1, Q_1=1, Q_0=0).
- The *Combinational Logic Encoder* takes the count from the 3-Bit Asynchronous Counter and drives the GREEN, YELLOW and RED lights as follows :
  - The GREEN light will be on when the count equals (1) or (2).
  - The YELLOW light will be on when the count equals (3) or (4).
  - The RED light will be on when the count equals (5) or (6).



Traffic Light Controller



Your task is to design the two sub-systems that make up the complete traffic light controller that meet the following design specifications.

Design Specifications:

3-Bit Asynchronous Counter

- Must be an ASYNCHRONOUS Counter.
- Must count from 1 to 6.
- Must use D flip-flops with Positive Edge Trigger & Active Low SET & RESET.
- May use any additional logic as needed.

Combinational Logic Encoder

- Must include a complete truth-table, K-Map and simplified logic equation for each output (GREEN, YELLOW, & RED) {HINT: The counter never outputs the count 000 or 111, thus these should be *don't cares* in your K-Map.}
- The logic for the GREEN output may only use 2-Input NOR gates (NOR only design).
- The logic for the YELLOW output may only use 2-Input AND; 2-Input OR; & Logic Inverters (AOI design).
- The logic for the RED output may only use 2-Input NAND gates (NAND only design).

The overall design will be graded based on the following criteria:

- Functionality – Did the design work?
- Specifications – Did you work within the limitations of the design specifications?
- Quality – Did the design use the minimum number of gates/flip-flops required?