

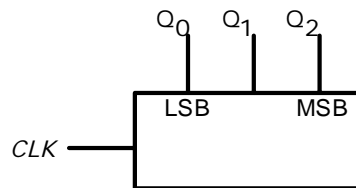
DEVELOPMENT OF DIGITAL SYSTEMS

Examination
27. 3. 2012

1. Implement the function f using as few multiplexers 4/1 as possible.

$$f(a, b, c, d) = (a \cdot \bar{b} + b \cdot c \cdot \bar{d} + b \cdot c) \cdot ((a \cdot c \cdot d) \cdot (\bar{c} + d))$$

2. Convert the hexadecimal number 59 into BCD notation using "double dabble" algorithm.
3. Implement a three bit synchronous counter, which counts up in Gray code using T type flip-flops and any logical gates. The counter has a three bit count output (Q_2 , Q_1 , Q_0) and a clock input (CLK). Name the signals according to figure below.



4. Draw the state transition diagram of a Moore type finite state machine, which controls the movement of a garage door. The control circuit has an input DOOR and an input PROTECTION, which is set to '1' whenever a current limit of the motor is reached. The motor current limit input is used to detect both door end positions as well as for protection against obstacles in the door path. The control circuit has a two bit motor output:

Operation code		Motor operation
OP_1	OP_0	
0	0	motor stop
0	1	door moving upwards
1	0	door moving downwards

When the door knob is pressed ($DOOR=1$), the door starts to move upwards. If an obstacle is in the door path or the door reaches its upper end position ($PROTECTION=1$), the motor stops. When the door knob is pressed again, the door starts to move downwards until the protection limit is reached again. After the door knob is pressed again, the process is repeated.