2004 Paper 2 Question 2

Digital Electronics

The functionality of a 2-to-4 line decoder is presented in the table below.

inputs			outputs			
A1	A0	EN	S3	S2	S1	S0
X	X	0	0	0	0	0
0	0	1	0	0	0	1
0	1	1	0	0	1	0
1	0	1	0	1	0	0
1	1	1	1	0	0	0

(*a*) What are the minimum sum-of-products equations for each output of the 2-to-4 line decoder? [4 marks]

(*b*) How can five 2-to-4 line decoders be used to produce a 4-to-16 line decoder? Illustrate your answer using a circuit diagram. [6 marks]

(*c*) An LED is to be controlled via a CMOS inverter. When the input to the inverter is 1, the LED should illuminate. The on current should not exceed 20mA at which point the voltage drop across the LED will be 1.5V. What circuit should be used to control the LED? Please include resistor values. [4 marks]

(*d*) You have been asked to design the output interface for a novelty clock which represents time using just 12 LEDs. The LEDs are arranged in a circle to represent the hours on an analogue clock. You have been provided with a time-keeping component which produces a 2Hz signal and two 4 bit outputs H and M representing hours and minutes, where

$$\begin{aligned} \text{H} &= \text{h mod } 12 \\ \text{M} &= \text{m div } 5 \\ \text{h} &= \text{hours (in the range 1 to 12)} \\ \text{m} &= \text{minutes (in the range 0 to 59)} \end{aligned}$$

The LED which represents the minute is to flash at 1Hz whereas the hour LED does not flash. If the same LED is being used for both the hour and minute, it should flash. Produce a circuit diagram which meets this specification, making good use of the 4-to-16 decoder parts. [6 marks]