2001 Paper 4 Question 6

ECAD

(*a*) When designing clocked circuits there are times when asynchronous inputs have to be sampled which may result in metastable behaviour in state holding elements. How might metastability be avoided when sampling asynchronous inputs? [5 marks]

(*b*) An optical shaft encoder (e.g. used on the internal rollers of a mechanical mouse) consists of a disk with an evenly spaced alternating transparent and opaque grating around the circumference. Two optical sensors are positioned such that when one sensor is at the middle of an opaque region, the other is at the edge. Consequently, the following Gray code sequence is produced, depending upon the direction of rotation:

positive rotation	negative rotation	
00	00	
01	10	time
11	11	
10	01	

A shaft decoder module is required to convert the Gray code into an 8-bit position. The 8-bit position should be incremented every time the input changes from one state to another in a positive direction (e.g. from 00 to 01, or from 10 to 00). Similarly, the 8-bit position should be decremented every time the input changes from one state to another in a negative direction (e.g. from 00 to 10, or from 01 to 00).

Write and comment a Verilog module which performs the function of a shaft decoder. [15 marks]