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**15/ENG02/028**

**COE 506**

**DIGITAL SYSTEM DESIGN USING VHDL**

**ASSIGNMENT SOLUTION**

**QUESTION 1**

1. ASIC -**Application Specific Integrated Circuits**

ASIC is an integrated circuit customized and created for a particular purpose rather than for general-purpose use. ASICs are used to implement analog, digital, as well as mixed-signal functionalities in high volume and high performance. The functionality of digital ASICs is generally described using a hardware description language (HDL), for example, Verilog and VHDL.

1. PAL- **Programmable Array Logic**

Programmable Array Logic (PAL) is a commonly used programmable logic device (PLD). It has programmable AND array and fixed OR array. Because only the AND array is programmable, it is easier to use but not flexible as compared to Programmable Logic Array (PLA). PAL’s only limitation is number of AND gates.

PAL consist of small programmable read only memory (PROM) and additional output logic used to implement a particular desired logic function with limited components.

1. PLA-**Programmable Logic Array**

A programmable logic array (PLA) is a kind of programmable logic device used to implement combinational logic circuits. The PLA has a set of programmable AND gate planes, which link to a set of programmable OR gate planes, which can then be conditionally complemented to produce an output. It has 2N AND Gates for N input variables, and for M outputs from PLA, there should be M OR Gates, each with programmable inputs from all of the AND gates. This layout allows for many logic functions to be synthesized in the sum of products canonical forms.

1. PLD- **Programmable Logic Device**

This is an integrated circuit that can be programmed to perform complex functions. A PLD consists of arrays of AND and OR gates. A system designer implements a logic design with a device programmer that blows fuses on the PLD to control gate operation.

1. CPLD- **Complex Programmable Logic Device**

A complex programmable logic device (CPLD) is a programmable logic device with complexity between that of PALs and FPGAs, and architectural features of both. The main building block of the CPLD is a macro cell, which contains logic implementing disjunctive normal form expressions and more specialized logic operations.

1. FPGA- **Field-Programmable Gate Array**

An FPGA is a device that contains a matrix of reconfigurable gate array logic circuitry. When a FPGA is configured, the internal circuitry is connected in a way that creates a hardware implementation of the software application. Unlike processors, FPGAs use dedicated hardware for processing logic and do not have an operating system.

**QUESTION 2**

Granularity of logic block has influence on performance of an FPGA. Typically, higher granularity level results in lesser delay between input and output. As the granularity of logic block increases, number of levels of logic in critical path decreases, and hence delay in critical path decreases. On the flip side with increase in granularity level average fan out increases and number of switches also increases as each block has more pins. Also the length of wires increases with increase in size of logic block.

**QUESTION 3**

Advantages of using PLDs are less board space, faster, lower power requirements (i.e., smaller power supplies), less costly assembly processes, higher reliability (fewer ICs and circuit connections means easier troubleshooting), and availability of design Software.

Yes, there are cases where hard wired logic gated would do a better job than programmable logic devices. In some cases, where speed of action and verifiable operation are necessary. Recall that hard-wired logic only does what it was wired to do. It does not depend on a computer program which may have errors/bugs in it. One advantage is that hard-wired logic can be verified by testing each component and the connections between them. Another advantage is that if the speed of the programmable device is not fast enough you may have to use a hardwired device.

**QUESTION 4**

Definitely, the stored program will be nonvolatile, but it will also be read-only. This is why fuse-programmed devices are sometimes called OTP which is an acronym for one time programmable and by definition this memory is a special type of non-volatile memory (NVM) that permits data to be written to memory only once. Once the memory has been programmed, it retains its value upon loss of power. OTP memory is used in applications where reliable and repeatable reading of data is required.

**QUESTION 5**

