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| **Course : EEL 6795** | **Name :** | **Date :** |
| **Question 1** | Discuss the different components of the overall power consumption in a CMOS-based electronic system? | |
| **Answer** | Energy is the utmost fundamental and basic ingredient that all electronics needs to work. There isn't a standalone system which can work without energy. Therefore, the energy is used to achieve the tasks, and the majority of it is converted into useful task, but it isn't usually converted into useful assignment, and some energy is undermined or wasted, which is known as electrical breakage. The scenario is identical in CMOS. There seem to be a number of places where electricity is squandered as in Static, Dynamic and Short Circuit Energy Dissipation.  For every aspect of the energy stated earlier has an interpretation linked with it because it has a beginning location or base of energy degradation. Whenever we speak about dynamic power, we're referring about the energy squandered between the changing actions of the capacitor and the capacitance linked with the electronics. Capacitors should be charged and discharged on a continuous basis, thus necessitates the use of energy. Nevertheless, energy is lost during the transition phase of the electrical transfer, and as a result, the energy or power used in this transitory time is dynamic power.  The static energy is generated by transistor energy drops, which exist even if the transistors aren't being utilized or in an activated state since energy is continually travelling between circuits, so this is the leaked energy that creates the Static Energy Drop. A short circuit component to energy is also there, but it only operates for a brief duration while all of the pulling upward and downward transistors are engaged. Throughout such time, a transparent path is formed, and energy is conducted across it, resulting in Short Circuit Energy. | |
| **Question 2** | Why the power/thermal-aware design is critical for today's electronic system design? | |
| **Answer** | Every component of the architecture relies on power for its basic functions, and every component has a unique ability to capture energy. No one could indeed truly surpass the stated energy pooling skills or pull the stated level since energy boundaries should be followed, and energy safe limit breaches indicate that unwarranted strength is trying to pass via the feature in correlation to the entity's minimal rating, as well as since severe energy harms the components. Because it has various advantages, such as decreasing the size of all the component or structure, dropping the energy rankings, decreasing the cost, and so on, power conscious computing architecture concentrates on systems that use the least quantity of energy or strength to run. As a consequence, power-conscious or thermally conscious computing is essential. | |
| **Question 3** | From your perspective, why does the industry change its gear from a high working frequency single processor to multi-core architecture? | |
| **Answer** | A single microchip has various constraints, including the capacity to control a limited number of requests at a time, the incapacity to do parallel system, and the abilities needed for its operation, to mention a few. In conclusion, it was unable to perform actions outside of the given range. To reduce computational burden, minimize complexity of the algorithm, and increase operational efficiency and usefulness in today’s world, processing has to be speedy, calculation periods must be brief, and several instructions must be handled concurrently. Numerous threads technique might meet every one of those needs because it can process numerous sets of instructions simultaneously and evaluate a large proportion of code lines simultaneously, increasing efficiency and usefulness while lowering real computing costs. | |
| **Question 4** | Explain the concept of concurrency and explain why Amdahl's law limits its application to a system. | |
| **Answer** | All applications typically have a number of different jobs and a set of occurrences that should be assessed as it is handled. The number of coding units to be processed is massive and executing such a large number of instructions takes a long time. As a consequence, resources are often wasted. This is when parallel processing comes into play. It's the idea that numerous action series are addressed or processed at the same moment, and that these input flows will have to share memory and resources, causing a slew of problems. Amdahl established Amdahl's law, which limits the utilization of concurrent computing and the amount to which it may be applied without reducing the device's overall effectiveness. It largely addressed how much system effectiveness might be increased by focusing on any part that needed improvement, as well as the maximum degree to which any design modification in the framework might be made. | |
| **Question 5** | What do we mean by technology mapping? How does it help to reduce the power consumption of an IC? | |
| **Answer** | The term "integrated circuit design" refers to the use of transistors in each circuitry. Logic gates, these are the transistors' fundamental parts, are found in large numbers in every transistor. Every operation might well have numerous logic gates, and every job necessitates the use of the proper logic gates. Any task may potentially be handled using a variety and mixtures of logic gates. There seems to be a completely separate netlist of logical gates in the current framework, but they are all abstract and thus unrelated to technology. As a result, the concept of development modelling techniques plays a role, and it handles to activate a dependable netlist of logic gates that have been linked to sophisticated technology, and highly technological collaborating gates then would contribute significantly to optimal resource consumption and minimal energy usage. | |
| **Question 6** | Discuss the advantages and disadvantages of the asynchronous design regarding energy efficiency. | |
| **Answer** | The primary two properties that all gadgets have in common are input variation and scheduling. At the moment, synchronous and asynchronous techniques are the most extensively utilized methods. Since the signals are binary however the time isn't really split, asynchronous technique clearly has a basic notion or basis. There are numerous advantages, it is claimed, if time is not split. Among the most crucial is the absence of clock skew, which is the difference in the pace at which the clock cycle arrives to different parts of the machine. Because of the absence of clock skew, the timer will not flip, reducing the charge-discharge phases connected with the capacitance and leading in lower energy consumption. Additionally, there have been no issues about global routing since this bulk of the infrastructure may be tweaked to get the highest feasible frequency response. There are specific challenges in an asynchronous context as well. One of numerous main issues when connected with synchronous devices would be that the design gets sophisticated and elegance is lost, results in a variety of technical hurdles. | |
| **Question 7** | Explain what "DVFS" is and why it is a commonly used technique in power and thermal-aware design. | |
| **Answer** | Since reducing the potential difference has a squared impact on productive energy usage, dynamic voltage and frequency scaling (DVFS) strategies, and also affiliated strategies like adaptive voltage and frequency scaling (AVFS), and dynamic voltage scaling (DVS), are useful in decreasing energy requirements. By cutting voltage level (and frequency) depending on the platform's anticipated productivity needs, DVFS techniques assist to decrease microchip energy usage on the go. Because it balances both frequency and voltage, DVFS is one of the few techniques which is effective across both dynamic and static energy. | |
| **Question 8** | Explain why using hierarchical bit lines and word line helps reduce the memory's power consumption. | |
| **Answer** | Because it is accountable for storing all documents, directories, as well as other types of material, memory is an essential element of the computing framework. It could be RAM or ROM, depending on the type of the data. Certain information might be obtained frequently, while others may not be as frequently requested. The content or information that is required on a routine schedule is stored in such a way that the lowest number of operations are required to access it, reducing time and power consumption. Memory, such as CMOS and SRAM, does have a big effect on energy use. The most critical component in effective energy distribution is energy consumption. Hierarchical bit lines and word bit lines have been used in such cases. Because bit lines are fragmented, there are more sub-bit segments. In a mixed new tiered structure, tiers are certainly extended, while bit line capacitance is reduced, leading in decreased power consumption. | |
| **Question 9** | Explain why the pipeline implementation of an IC circuit may help to save energy. | |
| **Answer** | Pipelining doesn't quiet, by itself, reduce energy usage. Pipelining reduces critical path delay by inserting registers throughout combinational circuits. While the logic operation is unaltered, the spread of anomalies among memory boundaries could be halted. The dynamic power is aided by the high frequency of the system clock to registers. Pipelining reduces the number of operations per clock pulse and therefore impacts energy usage owing to excessive branch misprediction charges as well as other risks. Time slack in the pipeline can be used for voltage scalability and gate minimization, leading in significant performance improvements. | |
| **Question 10** | Explain why general-purpose processors usually are less energy efficient than a customized processor (ASIC). | |
| **Answer** | All possible scenarios must be considered by general-purpose processors. It might be small or large, but every task has its own level of complexity, demanding a significant quantity of computer capacity to meet various conditions. Additionally, many operations require a specialized element that a general-purpose chip does not, rendering them inferior ideal for particular tasks and using more power. When we see bespoke processors, we know they're meant to carry out a certain task and were built specifically for that purpose. Processors will have enough computing power and memory to do the job. As an outcome, they are far better efficient in utilizing energy. | |
| **Question 11** | Explain the concepts of global and local clock gating. | |
| **Answer** | Every framework has a certain goal in mind, and in order to achieve that goal, every framework has a set of parts, all of which are assigned a set of goals, the types of which vary. Every element seems to have its own list of conditions for achieving such goals. Several sections have critical functions that need high voltage and frequency, but some are lesser important and remain the bulk of their tenure idle during operations. Clock gating significantly reduces dynamic power consumption by continuously feeding structure areas that require greater energy and switching ability with a control input, whereas elements that do not require energy all of the time really aren't supplied with a clock cycle, and thus clock gating substantially reduces dynamic power consumption. The clock may be local or global, depending on the limitations and the position of the clock outcome in the circuitry. | |
| **Question 12** | Explain why software optimizations are crucial for reducing the energy and power consumed by the system. | |
| **Answer** | Software is necessary to accomplish a given goal, and it takes a specific strategy to do so. The logic or operational procedures that underlying all applications are referred to as operational technique. This operational technique now depends on any approach that is devised to do the intended task, and every method is written in the scripting language of one's choosing. Sometimes, there is clearly room for betterment. The needs of the individual user may change over time, rendering the existing product commercially unprofitable and unfairly overpriced. The length of the performance or operational time, and also the amount of space required, are two requirements that may be improved at any time. It's important to monitor on the software's performance on a regular basis to ensure that it's not only meeting the demands of the client, but also maximizing asset usage and avoiding resource destruction. Since client demands may change at any time, it's critical to update approach functionality and system software on a frequent manner to guarantee the software's usefulness and productivity. | |
| **Question 13** | Watch the following lecture and provide a summary of it. "Stanford Seminar - The future of low power circuits and embedded intelligence". | |
| **Answer** | The video highlights existing low power technologies and how they can be implemented in embedded systems. The key principles presented are: already in use low power consumption technologies, evolved embedded technologies from time to time, connecting IoT with embedded systems, how IoT and embedded systems can be combined with energy efficient technologies? and the idea of embedded devices based on AI.  The focus is on technological breakthroughs and how devices may appear in the years ahead, and how rapidly transition is happening in the fields of study of embedded systems with the concept of AI, as well as how reduced power structures are a necessity of all of this transformation, and how updating existing low power configurations in the context of smart technology is required. | |