Unit-1: Binary Systems

1. **What are the different types of number systems? Explain each with an example.**
   - **Binary (Base-2)**: Uses digits 0 and 1. Example: 101021010_210102.
   - **Decimal (Base-10)**: Uses digits 0 to 9. Example: 34510345_{10}34510.
   - **Octal (Base-8)**: Uses digits 0 to 7. Example: 1578157_81578.
   - **Hexadecimal (Base-16)**: Uses digits 0 to 9 and letters A to F. Example: 2F3162F3_{16}2F316.
2. **How do you convert a decimal number to binary?**
   - Divide the number by 2, record the remainder, and repeat with the quotient until it is 0. The binary number is the sequence of remainders read from bottom to top.

- Example: Convert 13 to binary.

$$\begin{gathered} 13/2 = 6 \text{ remainder } 1 \\ 6/2 = 3 \text{ remainder } 0 \\ 3/2 = 1 \text{ remainder } 1 \\ 1/2 = 0 \text{ remainder } 1 \\ \text{Binary: } 1101_2 \end{gathered}$$

3. **Explain the concept of complements in binary numbers.**
   - **1's Complement**: Invert all bits (change 0s to 1s and 1s to 0s).
   - **2's Complement**: Add 1 to the 1's complement of the number. Used for representing negative numbers in binary.
4. **What is the difference between fixed-point and floating-point representation?**
   - **Fixed-point**: The decimal point is fixed in a predetermined position. It is simpler and faster but less flexible for representing a wide range of values.
   - **Floating-point**: The decimal point can float; it uses a fraction (mantissa) and an exponent. It allows for a wider range of values and greater precision.

Unit-2: Boolean Algebra

1. **Define Boolean algebra and explain its basic definitions.**
   - Boolean algebra is a mathematical structure that captures the rules of logic operations. It involves variables that take values of 0 or 1 and operators such as AND, OR, and NOT.
2. **What are the axioms of Boolean algebra?**
   - **Identity Law**: A+0=AA + 0 = AA+0=A and A·1=AA \cdot 1 = AA·1=A
   - **Null Law**: A+1=1A + 1 = 1A+1=1 and A·0=0A \cdot 0 = 0A·0=0
   - **Complement Law**: A+A‾=1A + \overline{A} = 1A+A=1 and A·A‾=0A \cdot \overline{A} = 0A·A=0
   - **Idempotent Law**: A+A=AA + A = AA+A=A and A·A=AA \cdot A = AA·A=A
3. **State and prove De Morgan's theorems.**

    - **First Theorem**: A·B‾=A‾+B‾\overline{A \cdot B} = \overline{A} + \overline{B}A·B=A+B
        - Proof: Using truth tables.
    - **Second Theorem**: A+B‾=A‾·B‾\overline{A + B} = \overline{A} \cdot \overline{B}A+B=A·B
        - Proof: Using truth tables.
4. **How do you simplify Boolean functions using Karnaugh maps?**
    - Plot the truth table values on a Karnaugh map.
    - Group adjacent 1s into the largest possible power-of-2 blocks.
    - Write the simplified Boolean expression from these groups.
5. **Explain the tabulation method for simplifying Boolean functions.**
    - Also known as the Quine-McCluskey method. List minterms, group by the number of 1s, and iteratively combine terms with a single differing bit until no further simplifications are possible.

Unit-3: Implementation of Combinational Logic Design

1. **What are logic gates? Explain the basic types with their truth tables.**
    - Logic gates perform basic logical functions:
        - **AND Gate**: Output is true if all inputs are true.
        - **OR Gate**: Output is true if at least one input is true.
        - **NOT Gate**: Output is the inverse of the input.
        - **NAND Gate**: Output is true if not all inputs are true.
        - **NOR Gate**: Output is true if no inputs are true.
        - **XOR Gate**: Output is true if inputs are different.
        - **XNOR Gate**: Output is true if inputs are the same.
2. **Describe the working of a binary adder and subtractor.**
    - **Binary Adder**: Adds binary numbers. A half adder adds two single bits (sum and carry), and a full adder adds three bits (including carry from previous addition).
    - **Binary Subtractor**: Subtracts binary numbers using the concept of complements.
3. **How does a decimal adder work?**
    - Adds decimal numbers represented in binary-coded decimal (BCD). Adjusts for any sum greater than 9 by adding 6 (0110 in binary).
4. **What is the function of an encoder and a decoder in digital circuits?**
    - **Encoder**: Converts an active input signal into a coded output signal.
    - **Decoder**: Converts coded inputs back into a set of outputs, typically binary to one-hot encoding.
5. **Explain the operation of a multiplexer and a demultiplexer.**
    - **Multiplexer (MUX)**: Selects one of several input signals and forwards it to a single output line.
    - **Demultiplexer (DEMUX)**: Takes a single input signal and routes it to one of several output lines.
6. **What are binary parallel adders and how do they function?**
    - A binary parallel adder adds two binary numbers simultaneously. It uses multiple full adders connected in parallel, with each full adder handling a pair of corresponding bits from the two numbers and a carry from the previous bit position.

Unit-4: Design of Synchronous Sequential Circuits

1. **What is a sequential circuit and how is it different from a combinational circuit?**
   - **Sequential Circuit**: Output depends on current inputs and previous states (has memory).
   - **Combinational Circuit**: Output depends only on current inputs (no memory).
2. **Explain the operation of latches and flip-flops.**
   - **Latch**: A simple storage device that operates with level-triggered inputs.
   - **Flip-Flop**: A storage device that operates with edge-triggered inputs, storing a single bit of data.
3. **How do you analyze clocked sequential circuits?**
   - Identify the states, input conditions, and the state transitions. Use state tables and diagrams to represent behavior.
4. **What is state reduction and state assignment in sequential circuit design?**
   - **State Reduction**: Minimizing the number of states without changing the external behavior of the circuit.
   - **State Assignment**: Assigning binary codes to the states in a way that simplifies the logic implementation.
5. **Describe the design and operation of counters.**
   - **Counters**: Sequential circuits that go through a predefined sequence of states. Types include binary counters, BCD counters, up/down counters.
6. **What are shift registers and ripple-counters?**
   - **Shift Registers**: Storage devices that shift the stored data bits in a specific direction (left/right) on each clock pulse.
   - **Ripple Counters**: Counters where the flip-flop output transition serves as a source for the clock input of the next flip-flop, causing a ripple effect.

Unit-5: Register Transfer and Microoperations

1. **What is Register Transfer Language (RTL)?**
   - A symbolic notation used to describe the operations, transfers, and sequences of data within a computer system.
2. **Explain the process of register transfer.**
   - The movement of data from one register to another within a computer's CPU, controlled by specific signals.
3. **How is data transferred between the bus and memory?**
   - Through control signals that specify the source and destination registers, and the operation to be performed.
4. **Describe arithmetic microoperations with examples.**
   - Operations such as addition, subtraction, increment, and decrement performed on binary data in registers.
   - Example: R3←R1+R2R3 \leftarrow R1 + R2R3←R1+R2
5. **What are logic microoperations? Provide examples.**
   - Operations such as AND, OR, XOR, and NOT performed on binary data.
   - Example: R3←R1 AND R2R3 \leftarrow R1 \, \text{AND} \, R2R3←R1ANDR2
6. **Explain shift microoperations.**
   - Operations that shift the bits of a register to the left or right.
   - Examples: Logical shift, arithmetic shift, circular shift.

Unit-6: Instruction Codes and Instruction Cycle

1. **What are instruction codes in computer architecture?**
   - Binary codes that represent specific operations to be performed by the CPU.
2. **Describe the common bus system.**
   - A communication pathway shared by multiple components of a computer system for data transfer.
3. **Explain the timing and control unit in a computer.**
   - Coordinates the timing and control signals for

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3. **Explain the timing and control unit in a computer.**
   - Coordinates the timing and control signals for all operations in a computer system. It ensures that operations are carried out in the correct sequence and at the right time by generating appropriate control signals.
4. **What are the different phases of the instruction cycle?**
   - **Fetch**: The instruction is fetched from memory.
   - **Decode**: The fetched instruction is decoded to determine the required action.
   - **Execute**: The decoded instruction is executed.
   - **Store**: The result of the execution is stored back in memory or a register.
5. **Discuss the various types of instructions in a computer.**
   - **Data Transfer Instructions**: Move data between registers, memory, and I/O devices (e.g., MOV, LOAD, STORE).
   - **Arithmetic Instructions**: Perform arithmetic operations (e.g., ADD, SUB, MUL, DIV).
   - **Logic Instructions**: Perform logical operations (e.g., AND, OR, XOR, NOT).
   - **Control Instructions**: Change the sequence of execution (e.g., JMP, CALL, RET, JZ).

Unit-7: Machine Language

1. **What is machine language and how is it different from high-level languages?**
   - **Machine Language**: The lowest-level programming language, consisting of binary code that is directly executed by the CPU.
   - **High-Level Languages**: More abstract and human-readable programming languages that need to be translated into machine language by compilers or interpreters.
2. **Explain the basics of assembly language.**
   - A low-level programming language that uses mnemonic codes and labels to represent machine-level instructions. It is closely related to machine language but easier to read and write.
3. **What is an assembler and what are its functions?**
   - An assembler is a program that translates assembly language code into machine language code. It also handles symbolic addresses, macros, and pseudo-instructions.
4. **How do program loops work in assembly language?**

- Program loops use jump instructions to repeat a sequence of instructions until a certain condition is met. For example, a loop might decrement a counter and jump back to the start of the loop until the counter reaches zero.

Unit-8: Machine Programming

1. **How do you perform arithmetic and logic operations in machine programming?**
   - Using specific machine instructions like ADD, SUB, MUL, DIV for arithmetic operations and AND, OR, XOR, NOT for logic operations.
2. **What are subroutines and how are they used in programming?**
   - Subroutines are blocks of code that perform a specific task and can be called from multiple places within a program. They help modularize the code and avoid redundancy.
3. **Explain the process of input-output programming.**
   - Involves reading data from input devices and sending data to output devices using machine instructions like IN and OUT. This process often involves interfacing with hardware and managing device-specific protocols.
4. **Discuss the implementation of programming loops in assembly language.**
   - Loops are implemented using conditional and unconditional jump instructions to create repetitive structures. Example: A decrementing counter loop that uses a comparison (CMP) and a conditional jump (JNZ - jump if not zero).

Unit-9: Register Organization

1. **What is general register organization in a CPU?**
   - The arrangement and utilization of registers within the CPU to store data temporarily during instruction execution. It includes general-purpose registers, special-purpose registers, and status registers.
2. **How are stacks organized in a computer system?**
   - Stacks are organized as LIFO (Last In, First Out) structures, typically using a stack pointer register to keep track of the top of the stack. Operations like push and pop are used to manage data in the stack.
3. **Explain the concept of Reverse Polish Notation (RPN).**
   - RPN is a postfix notation where operators follow their operands. It eliminates the need for parentheses in mathematical expressions. Example: The expression (3+4)×5(3 + 4) \times 5(3+4)×5 is written as 3 4 + 5 ×3 \, 4 \, + \, 5 \, \times34+5×.

Unit-10: Addressing Modes

1. **What are addressing modes in computer architecture?**
   - Addressing modes specify how the operand of an instruction is determined. Examples include immediate, direct, indirect, register, indexed, and based addressing modes.
2. **Explain RISC instructions and their characteristics.**
   - RISC (Reduced Instruction Set Computer) instructions are simple and executed within a single clock cycle. Characteristics include a large number of general-purpose registers, a load/store architecture, and a focus on optimizing instruction execution speed.
3. **Describe zero address instructions with examples.**

- Zero address instructions operate on an implicit stack. Example: The expression A+BA + BA+B is executed as PUSH A, PUSH B, ADD.

4. **What are one address instructions? Provide examples.**
   - One address instructions use a single address field. Example: ADD A (adds the value at address A to the accumulator).
5. **Explain two address and three address instructions with examples.**
   - **Two Address Instructions**: Use two address fields. Example: MOV A, B (copies the value from B to A).
   - **Three Address Instructions**: Use three address fields. Example: ADD A, B, C (adds values at B and C and stores the result in A).

Unit-11: Pipeline Processing

1. **What is instruction pipelining and how does it work?**
   - Instruction pipelining divides instruction execution into stages, allowing multiple instructions to be processed simultaneously in a pipeline fashion. Each stage completes a part of the instruction cycle (fetch, decode, execute, etc.).
2. **Describe arithmetic pipelining.**
   - Arithmetic pipelining divides arithmetic operations into stages, enabling the CPU to work on different parts of multiple arithmetic operations simultaneously, improving throughput.
3. **What are pipeline hazards and how are they resolved?**
   - **Pipeline Hazards**: Situations that prevent the next instruction in the pipeline from executing in its designated clock cycle.
     - **Data Hazards**: Occur when instructions depend on the results of previous instructions.
     - **Control Hazards**: Occur due to branch instructions.
     - **Structural Hazards**: Occur when hardware resources are insufficient.
   - **Resolution Techniques**: Stalling, forwarding, branch prediction, and hazard detection units.
4. **Explain the concept of parallel processing.**
   - Parallel processing involves the simultaneous execution of multiple tasks to improve computational speed and efficiency. It can be achieved through multiple processors (multi-core), SIMD (Single Instruction, Multiple Data), or MIMD (Multiple Instruction, Multiple Data) architectures.

Unit-12: Memory Technology

1. **What is cache memory and how does it fit into the memory hierarchy?**
   - Cache memory is a small, high-speed memory located close to the CPU that stores frequently accessed data to reduce access time to main memory. It is part of the memory hierarchy, which includes registers, cache, main memory, and secondary storage.
2. **Explain the concept of virtual memory and its management.**
   - Virtual memory extends the available physical memory using disk space, allowing the execution of larger programs. It is managed using paging and segmentation to swap data between physical memory and disk.
3. **Discuss the memory hierarchy in computer systems.**
   - The memory hierarchy organizes memory types by speed and size:

        - **Registers**: Fastest, smallest, and closest to the CPU.
        - **Cache Memory**: Faster than main memory, but smaller in size.
        - **Main Memory (RAM)**: Slower than cache, but larger.
        - **Secondary Storage**: Slowest and largest (e.g., HDD, SSD).
4. **What is associative memory?**
    - Also known as content-addressable memory (CAM), it allows data retrieval based on content rather than address, enabling fast searches for data patterns.
5. **How does cache memory work?**
    - Cache memory stores copies of frequently accessed data from main memory. It uses various policies for data replacement (e.g., LRU, FIFO) and mapping (e.g., direct-mapped, associative) to manage the cache content.

Unit-13: I/O Subsystems

1. **What are input-output devices? Provide examples.**
    - Devices that allow a computer to interact with the external world. Examples: keyboard, mouse, monitor, printer, hard drive.
2. **How do you interface with IO devices?**
    - Interfacing involves using controllers and ports to connect IO devices to the computer system, enabling data transfer between the CPU and the devices.
3. **Explain the concept of handshaking in data transfer.**
    - Handshaking is a protocol that coordinates data transfer between devices using control signals to ensure data is sent and received correctly.
4. **What is DMA (Direct Memory Access) and how does it work?**
    - DMA allows peripheral devices to directly transfer data to/from memory without CPU intervention, improving data transfer efficiency and freeing up CPU resources for other tasks.
5. **Describe asynchronous data transfer.**
    - Asynchronous data transfer occurs without a common clock signal, using start and stop bits to synchronize the data transmission, often used in serial communication.

Unit-14: Hardware Description Logic

1. **What is hardware description language (HDL)?**
    - A specialized language used to describe and model the behavior and structure of digital circuits. Examples include VHDL and Verilog.
2. **How is HDL used for designing combinational circuits?**
    - HDL allows designers to describe the logic functions and interconnections of combinational circuits using text-based code, which can then be simulated