DIGITAL ELECTRONICS BASICS - ANSWER KEY (Total: 100 marks)

Question 1: (10 marks)

Explain the difference between analog and digital signals.

- Definition of analog signals as continuous waveforms (2 marks)
- Definition of digital signals as discrete values (0s and 1s) (2 marks)
- Contrast between continuous vs. discrete representation (2 marks)
- Advantages of digital signals (noise immunity, processing ease) (2 marks)
- Example or application comparing both types (2 marks)

Question 2: (10 marks)

What is Boolean algebra and why is it important in digital electronics?

- Definition of Boolean algebra as a mathematical system for binary values (2 marks)
- Mention of basic operations (AND, OR, NOT) (2 marks)
- Connection to George Boole (1 mark)
- Explanation of importance in designing logic circuits (3 marks)
- Explanation of how Boolean expressions translate to hardware implementations (2 marks)

Question 3: (10 marks)

Describe how a NAND gate can be used as a universal gate.

- Definition of a universal gate (2 marks)
- Explanation of how to create NOT gate using NAND (2 marks)
- Explanation of how to create AND gate using NAND (2 marks)
- Explanation of how to create OR gate using NAND (2 marks)
- Significance in integrated circuit design (2 marks)

Question 4: (10 marks)

Explain the concept of clock signals in digital systems.

- Definition of clock signals as timing references (2 marks)
- Explanation of synchronization function (2 marks)
- Relationship between clock frequency and system speed (2 marks)
- Prevention of timing hazards (2 marks)
- Importance in sequential circuits (2 marks)

Question 5: (10 marks)

What is the difference between combinational and sequential logic circuits?

- Definition of combinational circuits (2 marks)
- Definition of sequential circuits (2 marks)
- Explanation of memory/state dependency in sequential circuits (2 marks)
- Examples of each type (2 marks)
- Applications or use cases of each type (2 marks)

Question 6: (10 marks)

Explain how a D flip-flop works.

- Definition as a memory element (2 marks)
- Description of D and clock inputs (2 marks)
- Explanation of data capture on clock transition (2 marks)
- Mention of state retention until next clock pulse (2 marks)
- Applications in registers and memory systems (2 marks)

Question 7: (10 marks)

What is multiplexing and why is it used in digital systems?

- Definition of multiplexing as selecting one of many inputs (2 marks)
- Explanation of control/select lines functionality (2 marks)
- Purpose of reducing required connections (2 marks)
- Example of a specific multiplexer (e.g., 4-to-1, 8-to-1) (2 marks)
- Application in digital systems (2 marks)

Question 8: (10 marks)

Explain the concept of propagation delay.

- Definition as time from input change to output change (3 marks)
- Explanation of cumulative effects in circuit chains (2 marks)

- Relationship to maximum operating frequency (2 marks)
- Factors affecting propagation delay (temperature, voltage, etc.) (2 marks)
- Impact on digital system design (1 mark)

Question 9: (10 marks)

What is the purpose of a decoder in digital systems?

- Definition of decoder functionality (binary input to multiple outputs) (3 marks)
- Explanation of n-to-2^n relationship (2 marks)
- Specific example (e.g., 3-to-8 decoder) (2 marks)
- Application in memory addressing (2 marks)
- Contrast with encoder or multiplexer (1 mark)

Question 10: (10 marks)

Describe the operation of a half adder and a full adder.

- Definition of half adder with inputs and outputs (2 marks)
- Implementation of half adder using XOR and AND gates (2 marks)
- Definition of full adder with inputs and outputs (2 marks)
- Implementation of full adder (relationship to half adders) (2 marks)
- Application in multi-bit arithmetic circuits (2 marks)