OET002 Digital Electronics Rubric Guide **Updated May 2, 2017**

The purpose of this guide is to provide a range of knowledge at which students can demonstrate proficiency for each objective. Subsequent college course success depends strongly on courses taught primarily at the "some applied skills demonstrated" and "applied skills strongly demonstrated" levels.

TAG Learning Outcomes	Applied skills strongly demonstrated	Some applied skills demonstrated	Little applied skills demonstrated	No applied skills demonstrated
1. Demonstrate an understanding of and application for number systems, operations, and codes.*	• Contrast binary versus Gray code potential error generation. • Choose error detection codes for an application.	• Perform addition and subtraction operations in binary and hexadecimal. • Convert fractional binary numbers.	• Convert between binary, decimal and hexadecimal by hand. • Convert between decimal and BCD by hand.	• Define Binary, Decimal and Hexadecimal. • Describe BCD, Gray code, and ASCII.
2. Identify various types of logic gates and explain their truth tables.*	• Construct and analyze logic gates with more than 2 inputs. • Measure voltages and logic levels (high, low, invalid) at inputs and outputs and compare to data sheets.	• Verify the physical functionality of the 7 common logic gates in a laboratory setting. • Contrast ideal electrical behavior versus real world measurements based on data sheets. • Construct and analyze timing diagrams.	• Construct truth tables for the 7 common logic gates. • Identify pin numbers and pinouts of logic gate ICs. • Interpret data sheets.	• Identify truth tables and the operation symbols for the 7 common logic gates.
3. Utilize Boolean Algebra to describe and simplify digital logic circuits.*	• Prove 12 basic rules of Boolean algebra. • Use 12 basic rules of Boolean algebra. • Develop Boolean Algebra equations for combinational logic circuits. • Develop SOP and POS Boolean Algebra equations from Truth Tables.	• Apply Boolean addition and multiplication. • Relate Boolean operations to appropriate logic gates. • Construct a Truth Table output for a combinational circuit using Boolean Algebra.	• Evaluate sum and product terms. • Describe commutative, associate and distribute laws. • Apply & compute Boolean Algebra operators to the 7 common logic gates.	• Define variable and literal. • Identify Boolean addition and multiplication. • Identify & explain Boolean Algebra operators.
4. Apply DeMorgan's theorem to simplify	• Simplify a logic expression by applying Boolean algebra and	• Develop a truth table and K map from a Boolean	• Explain the equivalency between NAND and Negative-	• Describe DeMorgan's theorem.

combinational logic circuits.*	DeMorgan's theorem. • Simplify a logic expression by applying K map. • Simplify Boolean Algebra equations using the 12 basic laws of simplification & DeMorgan's theorem. • Predict simplified SOP equations from K-maps. • Predict simplified POS equations from K-maps. • Prove simplified equations match original equations.	expression. • Compare the circuits to match both sides of the 12 basic laws of simplification. • Deduce how to group 1's in a SOP K-maps. • Deduce how to group 0's in a POS K-maps.	OR gate and NOR and Negative-AND gate using DeMorgan's theorem. • Evaluate a sum-of-products (SOP) expression. • Apply DeMorgan's theorem to combinational logic circuits. • Show how to place 1's in a SOP K-map. • Show how to place 0's in a POS K-map.	• Derive logic expression for a given logic circuit. • Define DeMorgan's theorem for NAND and NOR gates. • Identify the 12 basic laws of simplification. • Draw & label 2, 3, 4, & 5 variable K-maps.
5. Design combinational logic circuits to meet specified system requirements.*	• Design and build a simplified combinational circuit from a Boolean output expression Troubleshoot a combinational circuit with appropriate tools. • Construct & evaluate a Combinational circuit from a schematic. • Construct & evaluate a combinational circuit from a written logic scenario.	• Derive a logic circuit from a given truth table or a K map.	• Produce a Truth Table for a Combinational circuit. • Construct a K map from a truth table or logic circuit. • Write the Boolean output expression for a combinational circuit.	• Identify various logic gates in a combinational circuit. • Define combinational logic circuits. • List all input combinations for a circuit. • Draw schematics with correct symbols with ECAD.
6. Demonstrate an understanding of and applications for Encoders/decoders.*	• Build and troubleshoot a 74LS47 7-segment display circuit. • Design a logic circuit to decode or encode.	• Analyze how to cascade encoders and decoders. • Develop truth table based on the function of decoders and encoders.	• Explain the number of input and output bits for a decoder and encoder. • Identify the gates needed for a simple encoder and decoder.	• Define encoder and decoder. • Describe the function of binary-to-decimal decoder and decimal-to-BCD encoder.
7. Demonstrate an understanding of and applications for multiplexers/	• Wire and troubleshoot multiplexers/demultiplexers circuits. • Design a multiplexer to satisfy	• Expand multiplexers/ demultiplexers to handle more data lines. • Simplify the output	• Develop truth table based on the operation of multiplexers/ demultiplexers. • Describe 74HC157 multiplexer	• Describe the operation and function of multiplexers/ demultiplexers. • Describe applications of

demultiplexers.*	• a logic scenario. • Design a demultiplexer to satisfy a logic scenario.	• expression of multiplexers/ demultiplexers. • Analyze how to use a multiplexer as a function generator.	and 74HC154 demultiplexer. • Draw the logic diagram of multiplexers/demultiplexers. • Explain the uses of a multiplexer & a demultiplexer.	multiplexers/ demultiplexers. • Define a multiplexer & a demultiplexer.
8. Demonstrate an understanding of and applications for adders, subtractors, and Arithmetic Logic Units (ALUs).*	• Design and build adder and other ALU circuits with proper logic gates. • Troubleshoot the ALU circuits with proper tools.	• Draw logic diagrams of half-adder, full- adder and other ALUs. • Expand adders to multiple bits. • Analyze & apply commercial adders.	• Develop the truth tables of half- adder, full- adder and other ALUs. • Simplify the output expression of half- adder, full-adder and other ALUs. • Apply adders to solve multi-bit addition. • Explain two's compliment use for negative numbers. • Apply two's compliment to convert negative binary numbers. • Explain carry/borrow inputs and outputs.	• Describe the function of a half-adder and full-adder. • Describe the function of other ALUs. • Explain how adders can be used to subtract.
9. Explain the types of, operation of, and applications for flip-flops and related devices.*	• Wire flip-flops with understanding of "preset", "clear" and "clock". • Discuss the operating characteristics such as propagation delay, hold time and set-up time. • Interpret the applications such as timers. • Construct timing diagrams for latches and F-F's. • Design & construct latches & F-F's for various applications. • Design power on reset (POR)	• Identify and draw logic diagrams of various flip-flops. • Recognize the difference among S- R, D and J-K flip-flops. • Explain the difference between combinational and sequential circuits. • Analyze & compare asynchronous preset & clear operations.	• Explain clock pulses and edge-triggered flip-flops. • Explain the function of pulse transition detector. • Distinguish between a positive and negative edge- triggered flip-flops. • Draw Truth tables for latches & F-F's. • Produce Timing Diagrams for latches & F-F's.	• Describe structure, operation and application of various types of latches. • Distinguish between latches and flip-flops. • Identify latches & F-F's by their schematic symbols. • Explain latch & F-F operations.

	circuitry for latches & F-F's.			
10. Demonstrate an understanding of and applications for counters.*	• Determine and modify the modulus of a counter. • Identify and wire various types of counters such as up/down counters. • Design a counter with specified sequence states. • Construct timing diagrams for standard & truncated counters.	• Analyze the operation of decade asynchronous counters. • Analyze the operation of synchronous counters. • Analyze the difference between asynchronous and synchronous counters.	• Construct truth table for a sequential logic circuit. • Analyze counter timing diagrams. • Explain & apply synchronous & asynchronous cascading.	• Define the counters. • Describe the operation of a 2 bit asynchronous counter. • Identify counters by their schematic symbols. • Explain event counting & timing. • Explain synchronous & asynchronous counters. • Define binary & decimal (BCD) counters.
11. Demonstrate an understanding of and applications for shift registers.*	• Interpret applications of shift registers such as counters, time delay and data converter. • Wire and troubleshoot shift register. • Construct timing diagrams for various shift registers. • Design & construct shift registers for various applications.	• Analyze the operation of other shift registers such as bi-directional. • Draw the wave forms of the output of shift registers.	• Describe the structure and operation of serial in/serial out, serial in/parallel out, parallel in/serial out and parallel in/parallel out shift register. • Identify & explain Johnson & Ring counters and their use.	• Explain how a flip-flop stores and transfer data. • Identify logic symbols of various shift registers. • Identify basic forms of data movement in shift registers. • Explain event counting & timing.
12. Utilize and explain the types of memory and storage in digital circuits.*	• Describe the unique structure and performance of flash memory. • Design & construct circuitry for memory expansion. • Design & construct memory circuits for various applications.	• Explain what RAMs are made of and how they work. • Explain what ROMs are made of and how they work. • Compare the RAM and ROM for their advantages and disadvantages. • Analyze techniques for memory expansion.	• Describe the function of three types of buses such as address, data and control. • Describe the basic read and write operation. • Identify & explain RAM & ROM inputs and outputs. • Compute address size and organization of memory from inputs & outputs.	• Describe the basic organization of a memory. • Explain the capacity and address of a memory. • Identify & explain RAM & ROM inputs and outputs. • Compute address size and organization of memory from inputs & outputs.

13. Explain the development of and applications for integrated circuit technologies.*	• Compare CMOS and TTL in term of their performance. • Build and measure a few logic gates with transistors.	• Interpret the operation of various logic gates such as inverters, NAND and NOR gates implemented by MOSFETs. • Interpret the operation of various logic gates such as inverters, NAND and NOR gates implemented by BJTs. • Compare performance parameters of logic families.	• Read and obtain information from the data sheet of IC devices. • Explain the basic operation of MOSFETs and BJTs. • Identify MOSFETs and BJTs by their symbols.	• Discuss basic IC characteristics such as logic levels, noise margin and fan-out. • Explain how propagation delay affects the circuit speed. • List various logic families. • Identify various packaging styles. • Define complexity SSI through ULSI (Gates through microprocessors).