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<tr>
<td>1. Number systems, operations and codes*</td>
<td>• Contrast binary versus Gray code potential error generation. • Choose error detection codes for an application.</td>
<td>• Perform addition and subtraction operations in binary and hexadecimal. • Convert fractional binary numbers.</td>
<td>• Convert between binary, decimal and hexadecimal by hand. • Convert between decimal and BCD by hand.</td>
<td>• Define Binary, Decimal and Hexadecimal. • Describe BCD, Gray code, and ASCII.</td>
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<td>2. Logic gates*</td>
<td>• 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.</td>
<td>• 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.</td>
<td>• Construct truth tables for the 7 common logic gates. • Identify pin numbers and pinouts of logic gate ICs. • Interpret data sheets.</td>
<td>• Identify truth tables and the operation symbols for the 7 common logic gates.</td>
</tr>
<tr>
<td>3. Boolean Algebra *</td>
<td>• Prove 12 basic rules of Boolean algebra • Use 12 basic rules of Boolean algebra • Develop Boolean Algebra equations for combinational logic circuits.</td>
<td>• Apply Boolean addition and multiplication • Relate Boolean operations to appropriate logic gates • Construct a Truth</td>
<td>• Evaluate sum and product terms • Describe commutative, associate and distribute laws • Apply &amp; compute Boolean Algebra</td>
<td>• Define variable and literal • Identify Boolean addition and multiplication • Identify &amp; explain Boolean Algebra operators.</td>
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<td>4. DeMorgan’s theorem and logic simplification*</td>
<td>• Develop SOP and POS Boolean Algebra equations from Truth Tables.</td>
<td>Table output for a combinational circuit using Boolean Algebra.</td>
<td>operators to the 7 common logic gates.</td>
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| 5. Combinational logic circuits* | - 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. 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. Multiplexers/demultiplexers* | - Wire and troubleshoot multiplexers/demultiplexers circuits  
- Design a multiplexer to satisfy a logic | - Expand multiplexers/demultiplexers to handle more data lines  
- Simplify the output | - Develop truth table based on the operation of multiplexers/demultiplexers | - Describe the operation and function of multiplexers/demultiplexers |
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| 8. Adders, subtractors, ALUs* | • Design a demultiplexer to satisfy a logic scenario.  
• Analyze how to use a multiplexer as a function generator.  
• Describe 74HC157 multiplexer and 74HC154 demultiplexer  
• Draw the logic diagram of multiplexers/demultiplexers  
• Explain the uses of a multiplexer & a demultiplexer.  
• Describe applications of multiplexers/demultiplexers  
• Define a multiplexer & a demultiplexer. | • Design and build adder and other ALU circuits with proper logic gates.  
• Troubleshoot the ALU circuits with proper tools.  
• 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. | • Draw logic diagrams of half-adder, full-adder and other ALUs  
• Expand adders to multiple bits.  
• Analyze & apply commercial adders.  
• Apply adders to solve multi-bit addition.  
• Explain two’s compliment use for negative numbers.  
• Apply two’s compliment to convert negative binary numbers. | • 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.  

Working document. Last revised May 24, 2013
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<td>9. Flip-flops and related devices*</td>
<td>• 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 &amp; construct latches &amp; F-F’s for various applications. • Design power on reset (POR) circuitry for latches &amp; F-F’s.</td>
<td>• 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 &amp; Compare asynchronous preset &amp; clear operations.</td>
<td>• 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 &amp; F-F’s. • Produce Timing Diagrams for latches &amp; F-F’s.</td>
<td>• Describe structure, operation and application of various types of latches • Distinguish between latches and flip-flops • Identify latches &amp; F-F’s by their schematic symbols. • Explain latch &amp; F-F operations.</td>
</tr>
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<td>10. Counters*</td>
<td>• Determine and modify the modulus of a counter • Identify and wire</td>
<td>• Analyze the operation of decade asynchronous counters</td>
<td>• Construct truth table for a sequential logic circuit • Analyze counter</td>
<td>• Define the counters • Describe the operation of a 2 bit asynchronous counter</td>
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|           | various types of counters such as up/down counters  
• Design a counter with specified sequence states  
• Construct timing diagrams for std. & truncated counters.  | ● Analyze the operation of synchronous counters  
● Analyze the difference between asynchronous and synchronous counters  | timing diagrams  
● Explain diagrams  
● Explain asynchronous & synchronous cascading.  | ● Identify counters by their schematic symbols.  
● Explain event counting & timing.  
● Explain synchronous & asynchronous counters.  
● Define binary & decimal (BCD) counters.  |
| 11. 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. Memory and storage* | ● Describe the unique structure and performance of flash memory  | ● Explain what RAMs are made of and how they work  
● Explain what ROMs  | Describe the function of three types of buses such as address, data and control  | Describe the basic organization of a memory  
● Explain the capacity  |
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<td>Objective</td>
<td>Design &amp; construct circuitry for memory expansion.</td>
<td>are made of and how they work</td>
<td>Describe the basic read and write operation</td>
<td>and address of a memory</td>
</tr>
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<td>Objective</td>
<td>Design &amp; construct memory circuits for various applications.</td>
<td>Compare the RAM and ROM for their advantages and disadvantages.</td>
<td>Identify &amp; explain RAM &amp; ROM inputs and outputs.</td>
<td>Identify &amp; explain RAM &amp; ROM inputs and outputs.</td>
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<td>Analyze techniques for memory expansion.</td>
<td>Compute address size and organization of memory from inputs &amp; outputs.</td>
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<td>13. Integrated circuit technologies*</td>
<td>Compare CMOS and TTL in term of their performance</td>
<td>Interpret the operation of various logic gates such as inverters, NAND and NOR gates implemented by MOSFETs</td>
<td>Read and obtain information from the data sheet of IC devices</td>
<td>Discuss basic IC characteristics such as logic levels, noise margin and fan-out</td>
</tr>
<tr>
<td>Objective</td>
<td>Build and measure a few logic gates with transistors</td>
<td>Interpret the operation of various logic gates such as inverters, NAND and NOR gates implemented by BJTs</td>
<td>Explain the basic operation of MOSFETs and BJTs</td>
<td>Explain how propagation delay affects the circuit speed</td>
</tr>
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<td>Objective</td>
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<td>Compare performance parameters of logic families.</td>
<td>Identify MOSFETs and BJTs by their symbols</td>
<td>List various logic families.</td>
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<td>Identify various packaging styles.</td>
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<td></td>
<td>Define complexity SSI through ULSI (Gates through microprocessors).</td>
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| 14. VHDL topics | - Program a logic circuit using both text and graph  
- Program, compile, simulate, download and run a logic circuit | - Explain the entire design flow  
- Explain each step in the design such as simulation, synthesis and download  
- Compare GAL’s and PLA’s. | - Distinguish between schematic and text entry  
- Discuss the function of a compiler  
- Produce HDL descriptions | - Define programmable logic device  
- Define hardware description language  
- Define HDL  
- Identify HDL programmers. |
| 15. Introduction to microprocessors, computers and buses | - Identify different levels of programming languages  
- Discuss how the interrupts work in a computer  
- Write simple machine language programs. | - Describe the sequence of a standard process in a microprocessor  
- Identify three types of buses  
- Compare high level language and machine language.  
- Compare polling and interrupt operation. | - Describe what each component of a computer does  
- List the basic components of a microprocessor  
- Define and compare an OS and a user program.  
- Explain the Fetch/execute system. | - List the basic components of a computer  
- Discuss the function of software and hardware  
- List & explain std. computer buses.  
- List & explain a std. computer’s CPU, Memory, and I/O.  
- Define DMA, co-processors, & multitasking. |
| 16. Introduction to digital signal processing (DSP) | - Name the basic elements in a DSP  
- Explain how a DSP works  
- Wire and troubleshoot ADC and DAC | - Explain the operation of various types of ADC and DAC  
- Analyze errors caused by conversions. | - Discuss the sampling theorem  
- Discuss the purpose of filtering and sample-and-hold function | - State the purpose of ADC and DAC  
- Define DSP. |
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<td>17. Digital communications and transmission standards</td>
<td>Interpret the operation of typical error detection technique in a digital transmission system</td>
<td>Interpret the function of multiplexer/demultiplexer in a digital transmission system</td>
<td>Discuss the operation of serial and parallel data transfer</td>
<td>State the advantages of digital communication over analog one</td>
</tr>
<tr>
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<td>Distinguish between odd and even parity technique</td>
<td>Compare Bit rate and Baud rate.</td>
<td>Describe the sampling theorem</td>
<td>Explain how the information is transferred by digital signals</td>
</tr>
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<td></td>
<td>Interpret a complete digital communication and transmission system and identify the basic components in it</td>
<td></td>
<td>Compute throughput and efficiency of transmission.</td>
<td>List std. serial and parallel data transmission options.</td>
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<td>Construct simple circuits to do data transmission to computers.</td>
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<td>List std. serial and parallel data transmission media.</td>
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<td>Describe modulation techniques.</td>
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