

# Digital Electronics 2

## Course Outcome Summary

### Course Information

<b>Organization</b>	Madison Area Technical College
<b>Developers</b>	Dr. Alberto Rodriguez (Some Learning Objectives adapted from Kleitz Digital Electronics)
<b>Development Date</b>	5/23/2005
<b>Revised Date</b>	6/17/2005
<b>Course Number</b>	10-605-119
<b>Instructional Level</b>	Associate Degree
<b>Potential Hours of Instruction</b>	90
<b>Total Credits</b>	3

### Description

Course covers digital logic circuits including basic gates, flip-flops, arithmetic circuits, counters, shift registers, multiplexing circuits, comparators, and other similar devices. Other topics include logic families; Boolean concepts; and number systems. Lab work includes individual project design, layout, construction, testing, and documentation.

### Types of Instruction

Instruction Type	Contact Hours	Credits
Classroom Presentation	36	2
On-Campus Lab	54	1

### Textbooks

William Kleitz. *Digital Electronics*. Prentice Hall. **Edition:** 7th. **Source:** Truax-Book Store.

### Learner Supplies

Digital Circuits Parts Kit. **Quantity:** 1. **Source:** Truax-Parts Shop.

Oscilloscope Leads. **Quantity:** 2.

Digital Multimeter. **Quantity:** 1.

Wire and wire stripper tool. **Quantity:** 1.

### Prerequisites

AC\_DC Electronics 1 (10-605-112)

Digital Electronics 1 (10-605-118)

Applied Electronics Mathematics 1 (10-605-171)

### Exit Learning Outcomes

#### Core Abilities

- A. Critical thinking
- B. Science and Technology

C. Ethics

## **Competencies**

### **A. Apply circuit minimization techniques**

#### **You will demonstrate your competence:**

- A.1. By submitting Boolean Algebra problem set
- A.2. By building an independently selected Boolean Algebra Application used to solve a simple problem (L)
- A.3. By submitting a Boolean Algebra Technical Report of the selected application (L)
- A.4. By submitting Karnaugh maps problems
- A.5. By building an independently selected Karnaugh Map Application used to solve a simple problem (L)
- A.6. By submitting a Karnaugh Maps technical report of the selected application (L)
- A.7. By actively participating in class on topics related to circuit minimization techniques
- A.8. By answering circuit minimization related problems in an exam completed by the due date

#### **Your performance will be successful when:**

- A.1. Boolean algebra problem includes the correct transformation of logic statements into equivalent Boolean algebra expressions
- A.2. Boolean Algebra problem includes the simplest expression
- A.3. Boolean algebra problem includes the correct expressions to a specific logical circuit
- A.4. Boolean algebra problem includes the corresponding circuit to a given Boolean expression
- A.5. Boolean algebra problem includes all intermediate steps to achieve the right solutions
- A.6. Boolean algebra problem solutions are clearly written
- A.7. Boolean algebra problem solutions are neatly presented
- A.8. Boolean Algebra Application Circuit is fully operational
- A.9. Boolean Algebra Application Circuit is correctly color coded
- A.10. Boolean Algebra Application Report is neatly presented
- A.11. Boolean Algebra Application Report is clearly written
- A.12. Boolean Algebra Application Report is typed in a word processor with embedded schematics and figures
- A.13. Karnaugh maps problems include the correct simplified circuit
- A.14. Karnaugh maps problems include the correct K-map associated with a Boolean expression
- A.15. Karnaugh maps problems include the correct K-Map associated with a logical expression
- A.16. Karnaugh maps problems include all intermediate steps to achieve the right solution
- A.17. Karnaugh maps problem solutions are clearly written
- A.18. Karnaugh maps problem solutions are neatly presented
- A.19. Karnaugh Maps Application Circuit is fully operational
- A.20. Karnaugh Maps Application Circuit is correctly color coded

- A.21. Karnaugh Maps Application Report is neatly presented
- A.22. Karnaugh Maps Application Report is clearly written
- A.23. Karnaugh Maps Application Report is typed in a word processor with embedded schematics and figures
- A.24. you arrive in class on time
- A.25. you listen attentively during class

**B. Develop encoder/decoder circuits**

**You will demonstrate your competence:**

- B.1. By submitting Encoder/Decoder problem set completed independently by the due date.
- B.2. By submitting Encoder/Decoder Multisim simulation completed independently by the due date
- B.3. By independently designing an Encoder/Decoder circuit that solves a real life application by the due date
- B.4. By submitting and Encoder/Decoder Design Report typed in a wordprocessor by the due date
- B.5. By answering Encoder/Decoder problems in an exam completed by the due date
- B.6. By actively participating in class on topics related to Encoder/Decoder circuits

**Your performance will be successful when:**

- B.1. Encoder/Decoder problem include the correct answer
- B.2. Encoder/Decoder problem are neatly presented
- B.3. Encoder/Decoder problem includes a reflection on learning
- B.4. Encoder/Decoder problem are clearly written
- B.5. encoder/decoder circuit simulations are fully operation
- B.6. encoder/decoder circuit simulations include the correct answers
- B.7. encoder/decoder application project includes a fully operational circuit that solves a real life application
- B.8. encoder/decoder application project includes embedded schematics and figures
- B.9. encoder/decoder application project is clearly written
- B.10. you arrive in class on time
- B.11. you listen attentively during class

**C. Develop multiplexer/de-multiplexer circuits**

**You will demonstrate your competence:**

- C.1. By submitting MUX/DMUX related problems completed independently by the due date.
- C.2. By submitting MUX/DMUX related Multisim simulations completed independently by the due date.
- C.3. By independently designing a simple digital circuit including MUX/DMUX that solves a real life application by the due date
- C.4. By submitting an MUX/DMUX design report typed in a wordprocessor by the due date
- C.5. By answering MUX/DMUX problems in an exam completed by the due date
- C.6. By actively participating in class on topics related to MUX/DMUX circuits

**Your performance will be successful when:**

- C.1. MUX/DMUX problems include the correct answer
- C.2. MUX/DMUX problems are clearly written

- C.3. MUX/DMUX problems are neatly presented
- C.4. MUX/DMUX circuit simulations are fully operational
- C.5. MUX/DMUX circuit simulations include the correct answers
- C.6. MUX/DMUX application project includes a fully operational circuit that solves a real life application
- C.7. MUX/DMUX application project includes embedded schematics and figures
- C.8. MUX/DMUX application project is clearly written
- C.9. you arrive in class on time
- C.10. you listen attentively during class

**D. Develop comparator circuits**

**You will demonstrate your competence:**

- D.1. By submitting comparator(s) related problems completed independently by the due date.
- D.2. By submitting comparator(s) problem related Multisim simulations completed independently by the due date.
- D.3. By actively participating in class activities
- D.4. By independently designing a simple digital circuit including comparator(s) that solves a real life application by the due date
- D.5. By submitting a comparator(s) circuit design report typed in a wordprocessor by the due date
- D.6. By answering comparator problems in an exam completed by the due date
- D.7. By actively participating in class on topics related to comparator circuits

**Your performance will be successful when:**

- D.1. Comparator(s) problems include the correct answer
- D.2. Comparator(s) problems are neatly presented
- D.3. Comparator(s) problems are clearly written
- D.4. Comparator(s) circuit computer simulations are fully operation
- D.5. Comparator(s) circuit computer simulations include the correct answers
- D.6. Comparator(s) circuit application project includes a fully operational circuit that solves a real life application
- D.7. Comparator(s) circuit application project report includes embedded schematics and figures
- D.8. Comparator(s) circuit application project report is clearly written
- D.9. you arrive in class on time
- D.10. you listen attentively during class

**E. Develop flip-flop circuits**

**You will demonstrate your competence:**

- E.1. By submitting flip-flop related problems completed independently by the due date.
- E.2. By submitting flip-flop problem related Multisim simulations completed independently by the due date.
- E.3. By actively participating in class activities
- E.4. By independently designing a simple digital circuit including flip-flop that solves a real life application by the due date
- E.5. By submitting a flip-flop circuit design report typed in a wordprocessor by the due date
- E.6. By answering flip-flop problems in an exam completed by the due date

E.7. By actively participating in class on topics related to flip-flop circuits

**Your performance will be successful when:**

- E.1. Flip-Flop problems include the correct answer
- E.2. Flip-Flop problem include the correct timing diagram
- E.3. Flip-Flop problems are neatly presented
- E.4. Flip-Flop problems are clearly written
- E.5. Flip-Flop circuit computer simulations are fully operation
- E.6. Flip-Flop circuit computer simulations include the correct answers
- E.7. Flip-Flop circuit application project includes a fully operational circuit that solves a real life application
- E.8. Flip-Flop circuit application project report includes embedded schematics and figures
- E.9. Flip-Flop circuit application project report is clearly written
- E.10. you arrive in class on time
- E.11. you listen attentively during class

**F. Develop digital oscillators (multivibrators) circuits**

**You will demonstrate your competence:**

- F.1. By submitting digital oscillator(s) related problems completed independently by the due date.
- F.2. By submitting digital oscillator(s) problem related Multisim simulations completed independently by the due date.
- F.3. By actively participating in class activities
- F.4. By independently designing a simple digital circuit including digital oscillator(s) that solves a real life application by the due date
- F.5. By submitting a digital oscillator(s) circuit design report typed in a wordprocessor by the due date
- F.6. By answering digital oscillators problems in an exam completed by the due date
- F.7. By actively participating in class on topics related to digital oscillators circuits

**Your performance will be successful when:**

- F.1. Digital Oscillator(s) problems include the correct answer
- F.2. Digital Oscillator(s) problem include the correct timing diagram
- F.3. Digital Oscillator(s) problems are neatly presented
- F.4. Digital Oscillator(s) problems are clearly written
- F.5. Digital Oscillator(s) circuit computer simulations are fully operation
- F.6. Digital Oscillator(s) circuit computer simulations include the correct answers
- F.7. Digital Oscillator(s) circuit application project includes a fully operational circuit that solves a real life application
- F.8. Flip-Flop/Register(s) circuit application project report includes embedded schematics and figures
- F.9. Flip-Flop/Register(s) circuit application project report is clearly written
- F.10. you arrive in class on time
- F.11. you listen attentively during class

**G. Develop three state devices**

**You will demonstrate your competence:**

- G.1. By submitting three state related problems completed independently by the due date.

- G.2. By submitting three state problem related Multisim simulations completed independently by the due date.
- G.3. By actively participating in class activities
- G.4. By independently designing a simple digital circuit including three state(s) that solves a real life application by the due date
- G.5. By submitting a three state circuit design report typed in a wordprocessor by the due date
- G.6. By actively participating in class on topics related to three state circuits
- G.7. By answering three state problems in an exam completed by the due date

**Your performance will be successful when:**

- G.1. three state problems include the correct answer
- G.2. three state problems are neatly presented
- G.3. three state problems are clearly written
- G.4. three state circuit computer simulations are fully operation
- G.5. three state circuit computer simulations include the correct answers
- G.6. three state circuit application project includes a fully operational circuit that solves a real life application
- G.7. three state circuit application project report includes embedded schematics and figures
- G.8. three state circuit application project report is clearly written
- G.9. you arrive in class on time
- G.10. you listen attentively during class

**H. Develop asynchronous/synchronous counters**

**You will demonstrate your competence:**

- H.1. By submitting asynchronous/synchronous related problems completed independently by the due date.
- H.2. By submitting asynchronous/synchronous state diagram problems completed independently by the due date.
- H.3. By submitting asynchronous/synchronous problem related Multisim simulations completed independently by the due date.
- H.4. By actively participating in class activities
- H.5. By independently designing a simple digital circuit including asynchronous/synchronous that solves a real life application by the due date
- H.6. By submitting a asynchronous/synchronous circuit design report typed in a wordprocessor by the due date
- H.7. By answering asynchronous/synchronous problems in an exam completed by the due date
- H.8. By actively participating in class on topics related to asynchronous/synchronous circuits

**Your performance will be successful when:**

- H.1. Asynchronous/Synchronous counter problems include the correct answer
- H.2. Asynchronous/Synchronous counter problems are neatly presented
- H.3. Asynchronous/Synchronous counter problems are clearly written
- H.4. Asynchronous/Synchronous counter state diagrams have the right number of states
- H.5. Asynchronous/Synchronous state diagrams problems have all states correctly labeled

- H.6. Asynchronous/Synchronous counter circuit computer simulations are fully operation
- H.7. Asynchronous/Synchronous counter circuit computer simulations include the correct answers
- H.8. Asynchronous/Synchronous counter circuit application project includes a fully operational circuit that solves a real life application
- H.9. Asynchronous/Synchronous counter circuit application project report includes embedded schematics and figures
- H.10. Asynchronous/Synchronous counter circuit application project report is clearly written
- H.11. you arrive in class on time
- H.12. you listen attentively during class

**I. Develop shift registers circuits**

**You will demonstrate your competence:**

- I.1. By submitting shift registers related problems completed independently by the due date. (H)
- I.2. By submitting shift registers problem related Multisim simulations completed independently by the due date. (H)
- I.3. By actively participating in class activities
- I.4. By independently designing a simple digital circuit including shift registers that solves a real life application by the due date (L)
- I.5. By submitting a shift registers circuit design report typed in a wordprocessor by the due date (L)
- I.6. By answering shift registers problems in an exam completed by the due date
- I.7. By actively participating in class on topics related to shift registers circuits

**Your performance will be successful when:**

- I.1. Shift registers problems include the correct answer
- I.2. Shift registers problems are neatly presented
- I.3. Shift registers problems are clearly written
- I.4. Shift registers circuit computer simulations are fully operation
- I.5. Shift registers circuit computer simulations include the correct answers
- I.6. Shift registers circuit application project includes a fully operational circuit that solves a real life application
- I.7. Shift registers circuit application project report includes embedded schematics and figures
- I.8. Shift registers circuit application project report is clearly written
- I.9. you arrive in class on time
- I.10. you listen attentively during class

**J. Develop Analog to Digital (A/D) and Digital to Analog (D/A) conversion circuits**

**You will demonstrate your competence:**

- J.1. By submitting D/A-A/D related problems completed independently by the due date.
- J.2. By submitting D/A-A/D problem related Multisim simulations completed independently by the due date.
- J.3. By actively participating in class activities
- J.4. By independently designing a simple digital circuit including D/A-A/D that solves a real life application by the due date

J.5. By submitting a D/A-A/D circuit design report typed in a wordprocessor by the due date

J.6. By answering A/D and D/A converter problems in an exam completed by the due date

J.7. By actively participating in class on topics related to A/D and D/A converter circuits

**Your performance will be successful when:**

J.1. D/A-A/D problems include the correct answer

J.2. D/A-A/D problems are neatly presented

J.3. D/A-A/D problems are clearly written

J.4. D/A-A/D circuit computer simulations are fully operation

J.5. D/A-A/D circuit computer simulations include the correct answers

J.6. D/A-A/D circuit application project includes a fully operational circuit that solves a real life application

J.7. D/A-A/D circuit application project report includes embedded schematics and figures

J.8. D/A-A/D circuit application project report is clearly written

J.9. you arrive in class on time

J.10. you listen attentively during class

**K. Develop ROM memory circuits**

**You will demonstrate your competence:**

K.1. By submitting ROM related problems completed independently by the due date.

K.2. By submitting ROM problem related Multisim simulations completed independently by the due date.

K.3. By actively participating in class activities

K.4. By programming a ROM memory chip

K.5. By demonstrating a programmed ROM memory chip interacting with other digital circuitry

K.6. By answering ROM memory problems in an exam completed by the due date

K.7. By actively participating in class on topics related to ROM memory circuits

**Your performance will be successful when:**

K.1. ROM memory problems include the correct answer

K.2. ROM memory problems are neatly presented

K.3. ROM memory problems are clearly written

K.4. ROM memory circuit computer simulations are fully operation

K.5. ROM memory circuit computer simulations include the correct answers

K.6. ROM memory chip program performs the correct task (L)

K.7. ROM memory circuit is correctly color coded (L)

K.8. you arrive in class on time

K.9. you listen attentively during class

**L. Develop computer programmable logic circuits**

**You will demonstrate your competence:**

L.1. By programming computer programmable logic devices (CPLD)

L.2. By submitting a CPLD related problems completed independently and by the due date

L.3. By answering CPLD problems in an exam completed by the due date

L.4. By actively participating in class on topics related to CPLD circuits

**Your performance will be successful when:**

- L.1. CPLD program compiles without errors
- L.2. CPLD program downloads into the target hardware
- L.3. CPLD target circuit correctly performs the intended task
- L.4. CPLD problems include the correct answer
- L.5. CPLD problems are clearly written
- L.6. CPLD problems are neatly presented
- L.7. you arrive in class on time
- L.8. you listen attentively during class

**M. Analyze components data sheets**

**You will demonstrate your competence:**

- M.1. Submitting a Circuit Description Report
- M.2. Submitting a Circuit Data Sheet
- M.3. Applying Data Sheet Relevant Information to an assigned circuit schematic

**Your performance will be successful when:**

- M.1. Circuit description report includes circuit pinout
- M.2. Circuit description report includes power characteristics
- M.3. Circuit description report included circuit behavior description
- M.4. Circuit description report I/O voltage levels
- M.5. Circuit description report includes manufacturers name
- M.6. Circuit description report includes unit price
- M.7. Circuit description report must be clearly written
- M.8. Circuit description report must be neatly presented
- M.9. Data Sheet Relevant Information is applied by identifying missing connections in the assigned schematic
- M.10. Circuit Data Sheet is independently obtained

**N. Assemble digital circuit from schematic.**

**You will demonstrate your competence:**

- N.1. By demonstrating an operational version of the specific digital circuit schematic completed by the due date
- N.2. By submitting an expected results (ER) sheet prior to assembling an assigned circuit schematic
- N.3. By submitting a laboratory questions/measurements (Q/M) sheet by the due date

**Your performance will be successful when:**

- N.1. ER sheet contains an accurate view of the expected circuit results
- N.2. Operational circuit performs the function it was designed to accomplish
- N.3. Operational circuit was assembled using color coded wires
- N.4. Q/M sheet includes is completely filled
- N.5. Q/M sheet includes measurements that fall within 10% of the correct/expected values
- N.6. Q/M sheet is neatly presented
- N.7. Q/M sheet is clearly written

**O. Troubleshoot digital circuits**

**You will demonstrate your competence:**

O.1. By submitting an error correction (EC) addendum to the circuit schematics requiring modifications

O.2. By articulating your troubleshooting thought process to your instructor

O.3. By demonstrating an operational version of the troubleshooted circuit

**Your performance will be successful when:**

O.1. Troubleshooting articulation is presented clearly

O.2. Troubleshooting articulation is presented logically

O.3. Final circuit is assembled and fully operational

O.4. Error Correction Addendum contains the operational version of the basic logic circuit schematic