I. INTRODUCTION

A. An entry level course in digital electronics to include numbering systems, logic gates, Boolean algebra, and combinational logic. This course will cover the fundamentals of basic gate and gating networks in digital electronics as well as the reduction of gating networks through the use of Boolean algebra and Karnaugh Maps. Flip-flops and their use as registers, counters and control circuits will be studied. Numbering systems, adders, and other arithmetic circuits are also discussed.

B. This course serves as a required or elective course on various degree plans. Curriculum plans for degrees and certificates, are listed in the current Central Texas College Catalog.

C. The delivery method of this course may be traditional lecture/lab, blended lecture/lab, or online.

D. Prerequisites: None

II. LEARNING OUTCOMES

Upon successful completion of this course, Digital Fundamentals, the student will be able to:

A. Construct digital circuits such as combinational logic circuits, clocking and timing circuits. (F3, F4, F5, F11, C5, C8)

B. Troubleshoot various digital circuits using schematic diagrams. (C6, F1, F5)

C. Explain the gray code, binary-, octal-, and hex codes and how they relate to each other (F3, F4, F5, F11, C5, C8)

D. Differentiate between the different logic gates and explain how each gate functions and how it differs from other gates in that operation. (C6, F1, F5)

E. Construct gating networks and explain their simplification through the use of DeMorgan’s theorem, Boolean laws and identities. (F9, F10, F11, F12)

F. Solve problems in Boolean algebra and explain its application to digital circuits.
G. Differentiate between the types of Flip Flops and their operation. (C5, C6, C8, F1, F5, F8, F11)

H. Explain IC specifications, encoding, decoding, and displays. (F5, F11)

I. Identify the many different types of counters and how to construct them (C5, C6, C8, F1, F5, F8, F11)

J. Solve binary arithmetic and explain how it is used in conjunction with half and full adders (F3, F4, F6)

III. INSTRUCTIONAL MATERIALS

The instructional materials identified for this course are viewable through www.cted.edu/books

IV. COURSE REQUIREMENTS

A. Attend both lecture and lab or in the case of online delivery, be actively engaged in Blackboard and maintain constant progress.

B. Be prepared to participate in discussion, team projects/assignments and take unannounced assessments relating to the lecture materials.

C. Complete all exams/assessments.

D. Submit all assignments on time.

V. ASSESSMENTS

A. Student content mastery will be evaluated in the following areas:
   - Quizzes (one for each of the units covered)
   - Final Assessment (comprehensive final exam)

B. Scheduled and unscheduled assessments will be given at the discretion of the instructor.

C. Exams/assessments may be composed of both subjective and objective questions plus computer output. Failure to pass the Final Exam will result in a maximum grade of “D” for the entire course.

D. A student must take all exams/assessments. No make-up exams/assessments will be given. Both online and on campus students who know in advance that they will be absent due to school sponsored trips, military duty or orders, or any other valid reason, must arrange to take an early exam/assessment. Unexpected absences due
to illness or other extenuating circumstances will require the student to see the instructor about make-up work in lieu of the missed exam/assessment.

E. Students with unexcused absences will be given a zero for each missed assignment.

VI. SEMESTER GRADE COMPUTATIONS

<table>
<thead>
<tr>
<th>Course Requirements</th>
<th>Points</th>
<th>Points</th>
<th>Grade</th>
<th>Quality Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>300</td>
<td>900-1000</td>
<td>A-Superior</td>
<td>4</td>
</tr>
<tr>
<td>Assessments</td>
<td>300</td>
<td>800-899</td>
<td>B-Above Average</td>
<td>3</td>
</tr>
<tr>
<td>Final Assessment*</td>
<td>400</td>
<td>700-799</td>
<td>C-Average</td>
<td>2</td>
</tr>
<tr>
<td>*Note: Must pass the final to pass the course</td>
<td>600 - 699</td>
<td>D – Passing but Unsatisfactory</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>1000</td>
<td>0 - 599</td>
<td>F-Failure</td>
<td>0</td>
</tr>
</tbody>
</table>

VII. NOTES AND ADDITIONAL INSTRUCTIONS FROM THE INSTRUCTOR

A. **Course Withdrawal:** It is the student’s responsibility to officially withdraw from a course if circumstances prevent attendance. Any student who desires to, or must, officially withdraw from a course after the first scheduled class meeting must file a Central Texas College Application for Withdrawal (CTC Form 59). The student must sign the withdrawal form.

CTC Form 59 will be accepted at any time prior to Friday of the 12th week of classes during the 16-week fall and spring semesters. The deadline for sessions of other lengths is:

- 10-week session Friday of the 8th week
- 8-week session Friday of the 6th week
- 5-week session Friday of the 4th week

The equivalent date (75% of the semester) will be used for sessions of other lengths. The specific last day to withdraw is published each semester in the Schedule Bulletin.

For non-GoArmyEd active military students, the effective date of withdrawal is the filing date with the Education Center. For all other students, the effective date of withdrawal is the date that the withdrawal application is received by the Central Texas College representative.

Students who used financial aid, military tuition assistance, VA benefits, or other non-personal funds may be required to repay tuition and fees to the funding agency. For specific repayment requirements, contact the Office of Student Financial Aid or Veterans Services Office before withdrawing. Military tuition
assistance students should visit their military Education Center or Navy College Office.

A student who officially withdraws will be awarded the grade of “W” provided the student’s attendance and academic performance are satisfactory at the time of official withdrawal. Students must file a withdrawal application with the College before they may be considered for withdrawal.

A student may not withdraw from a class for which the instructor has previously issued a grade of “F,” “FI,” “FN,” “IP,” or “XN.”

B. **Instructor Initiated Withdrawals**: Faculty are authorized to withdraw students who are not making satisfactory course progress to include failure to meet College attendance requirements as outlined in the section of the Catalog entitled “Satisfactory Progress Standards.” The instructor will assign the appropriate grade on CTC Form 59 for submission to the registrar.

Students enrolled in distance learning courses are expected to maintain constant progress throughout the course. Failure to do so may result in the student being administratively withdrawn by the instructor.

Students who have not attended class by the 12th class day of a 16-week course or the 6th class day of an 8-week term may be administratively withdrawn by the instructor with a grade of "W." Students may be administratively withdrawn from any class when their absences reach a total equal to 12.5% of the class hours for the course; and in the opinion of the instructor, the student cannot satisfactorily complete the course. An example: Students attending a 48-hour class during an 8-week period normally meet 180 minutes each session for 16 sessions. Those students accumulating two (2) unexcused absences are subject to Administrative Withdrawal since the total unexcused absences equal 12.5% of class hours for the course. Those students attending a 48-hour class during a 16-week period normally meet 90 minutes each session for 32 sessions. Those students accumulating four (4) unexcused absences are subject to Administrative Withdrawal since the total unexcused absences equals 12.5% of class hours for the course. In a distance learning course the last date of attendance is the last activity by the student in the course.

C. **Administrative Withdrawal**: A student may be administratively withdrawn by a designated member of the administrative staff of the College when the student has been placed on Academic Suspension or Disciplinary Suspension; the student has an outstanding financial obligation owed to the college; or the student registered for a course without the required prerequisite or departmental permission.

The College is under no obligation to refund tuition and fees, or other costs associated with an administrative or instructor initiated withdrawal.
D. **Incomplete Grade:** The College catalog states, “An incomplete grade may be given in those cases where the student has completed the majority of the coursework but, because of personal illness, death in the immediate family, or military orders, the student is unable to complete the requirements for a course…” Prior approval from the instructor is required before the grade of “IP” for Incomplete is recorded.

E. **Cell Phones and Pagers:** Students will silence cell phones and mobile devices while in the classroom or lab.

F. **Americans with Disabilities Act (ADA):** Disability Support Services provide services to students who have appropriate documentation of a disability. Students requiring accommodations for class are responsible for contacting the Office of Disability Support Services (DSS) located on the central campus. This service is available to all students, regardless of location. Review the website at [www.ctcd.edu/disability-support](http://www.ctcd.edu/disability-support) for further information. Reasonable accommodations will be given in accordance with the federal and state laws through the DSS office.

G. **Instructor Discretion:** The instructor reserves the right of final decision in course requirements and may make changes to the course outline and/or assignments as needed.

H. **Civility:** Individuals are expected to be aware of what a constructive educational experience is and be respectful of those participating in a learning environment. Failure to do so can result in disciplinary action up to and including expulsion.

I. **Degree Progression:** Students who receive a grade of “D” are advised not to enroll in the next course for which this course was a prerequisite.

J. **Failing Grade:** The grade of “F” or “FN” will be given for academic failure, non-attendance or scholastic dishonesty.

K. **Scholastic Honesty:** All students are expected to maintain the highest standards of scholastic honesty in the preparation of all course work and during examinations. The college policy on scholastic honesty, including definitions on plagiarism, collusion, and cheating can be found at the following URL: [http://online.ctcd.edu/plagiarism.cfm](http://online.ctcd.edu/plagiarism.cfm)
VIII. COURSE OUTLINE

A. Lesson One: Introductory Concepts

1. Learning Outcomes: Upon successful completion of this lesson the student will be able to:
   a. Explain the basic difference between digital and analog quantities.
   b. List the advantages and disadvantages of digital systems.
   c. Show how voltage levels are used to represent digital quantities.
   d. Describe serial and parallel data transmission and the benefits and shortcomings of each.

2. Learning Activities:
   a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
   b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. Unit Outline:
   a. Introduction to Digital 1s and 0s.
   b. Numerical Representations.
   c. Digital and Analog Systems.
   d. Digital Number Systems.
   e. Representing Binary Quantities.
   f. Digital Circuits/Logic Circuits.
   g. Parallel and Serial Transmission.
   h. Memory.
   i. Digital Computers.

B. Lesson Two: Number Systems and Codes

1. Learning Outcomes: Upon successful completion of this lesson the student will be able to:
   a. Review the decimal number system.
   b. Count in the binary number system.
   c. Convert from decimal to binary and from binary to decimal.
   d. Apply arithmetic operations to binary numbers.
   e. Convert between the binary and hexadecimal number system.
   f. Convert between the binary and octal number systems.
   g. Express decimal numbers in binary coded decimal (BCD) form.
   h. Convert between the binary system and the Gray code.
   i. Interpret the American Standard Code for Information Interchange (ASCII).

2. Learning Activities:
a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. **Unit Outline:**
   a. Binary-to-Decimal Conversions.
   b. Decimal-to-Binary Conversions.
   c. Hexadecimal Number System.
   d. BCD Code.
   e. The Gray Code.
   f. Putting it All Together.

C. **Lesson Three: Describing Logic Circuits (ch.3) & Combinational Logic Circuits (4)**

1. **Learning Outcomes:** Upon successful completion of this lesson the student will be able to:
   a. Describe the operation of the inverter, the AND gate and the OR gate.
   b. Describe the operation of the NAND gate and the NOR gate.
   c. Express the operation of NOT, AND, OR, NAND, and NOR gates using Boolean symbols.
   d. Describe the operation of the Exclusive-OR and Exclusive-NOR gates.
   e. Recognize and use both the distinctive shape logic gate symbols and the rectangular outline logic gate symbols of ANSI/IEEE Standard 91-1984.
   f. Construct timing diagrams showing the proper time relationships of inputs and outputs for the various logic gates.
   g. Make basic comparisons between the major IC technologies- CMOS and TTL.
   h. Explain how the various series within the CMOS and TTL families differ from one another.
   i. Define propagation delay time and fan-out.
   j. Use each logic gate in simple applications.
   k. Troubleshoot logic gates for proper inputs and outputs by using the logic probe.
   l. Describe the basic concepts of programmable logic.

2. **Learning Activities:**
   a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
   b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. **Unit Outline** (3)
   a. Boolean Constants and Variables
   b. Truth Tables
c. OR Operation with OR Gates
d. AND Operation with AND Gates
e. NOT Operation
f. Describing Logic Circuits Algebraically
g. Evaluating Logic-Circuit Outputs
h. HDL Format and Syntax
i. Intermediate Signals

Unit Outline (4)
a. Sum-of-Products Form
b. Simplifying Logic Circuits
c. Algebraic Simplification
d. Designing combinational Logic Circuits
e. Karnaugh Map Method
f. Programmable Logic Devices
g. Truth Tables Using HDL

D. Lesson Four: Logic Boolean Algebra and Karnaugh Mapping (3&4)

1. Learning Outcomes: Upon successful completion of this lesson the student will be able to:
   a. Apply the Single and Multivariable Theorems of Boolean algebra to circuits.
   b. Apply Derived Expressions to logic circuits.
   c. Apply DeMorgan’s theorems to Boolean expressions.
   d. Evaluate Boolean expressions.
   e. Simplify expressions by using the laws and rules of Boolean algebra.
   f. Understand the difference between SOP and POS expressions and convert from one to the other.
   g. Use a Karnaugh map to simplify Boolean expressions.
   h. Utilize “don’t care” condition to simplify logic functions.
   i. Apply Boolean algebra and the Karnaugh map method to a system application.

2. Learning Activities:
   a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
   b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. Unit Outline: (4)
   a. Sum-of-Products Form
   b. Simplifying Logic Circuits
   c. Algebraic Simplification
d. Designing Combinational Logic Circuits
e. Troubleshooting Digital Systems
E. Lesson Five: Chapters 8 and 4

1. Learning Outcomes: Upon successful completion of this lesson the student will be able to:
   a. Understand IC terminology and read data sheets.
   b. Compare the characteristics of CMOS and TTL Logic Families.
   c. Determine fan-out for devices.
   d. Understand tri-state devices.
   e. Analyze basic combinational logic circuits to determine functionality.
   f. Find faults in integrated circuits and external to the IC.
   g. Understand Parity generation and checking.

2. Learning Activities:
   a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
   b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. Unit Outline:
   a. Sum-of-Products Form
   b. Simplifying Logic Circuits
   c. Algebraic Simplification
   d. Designing Combinational Logic Circuit
   e. Karnaugh Map Method
   f. Exclusive-OR and Exclusive-NOR Circuits
   g. Digital IC Terminology
   h. The TTL Logic Family
   i. TTL Data Sheets
   j. Other TTL Characteristics

F. Lesson Six: Flip-Flops and Related Devices (5)

1. Learning Outcomes: Upon successful completion of this lesson the student will be able to:
   a. Construct a 555 timer to operate as either an astable multivibrator or a one-shot
   b. Construct a 555 to operate as a bistable device (clock).
   c. Use logic gates to construct basic latches.
d. Explain the difference between an S-R latch and a D latch.
e. Recognize the difference between a latch and a flip-flop.
g. Understand edge-triggering and how it can be implemented.
h. Understand the significance of propagation delays, set-up time, hold time, maximum operating frequency, minimum clock pulse widths, and power dissipation in the application of flip-flops.
i. Analyze circuits for race conditions and the occurrence of glitches.
j. Troubleshoot basic flip-flop circuits.
k. Identify the basic forms of data movement in shift registers.
l. Explain how serial in/serial out, serial in/parallel out, parallel in/serial out, and parallel in/parallel out shift registers operate.
m. Describe how a bidirectional shift register operates.
n. Determine the sequence of a Johnson counter.
o. Construct a ring counter from a shift register.

2. Learning Activities:
a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. Unit Outline:
a. Clocked S-R Flip-Flops
b. Clocked J-K Flip-Flop
c. Clocked D Flip-Flop
d. Serial Data Transfer: Shift Registers
e. Edge-Triggered Devices

G. Lesson Seven: Counters and Registers

1. Learning Outcomes: Upon successful completion of this lesson the student will be able to:
a. Describe the difference between an asynchronous and a synchronous Counter
b. Analyze counter circuits.
c. Build an up/down counters (asynchronous and synchronous) to generate forward and reverse binary sequences.
d. Build a circuit to convert binary to decimal.
e. Use IC counters in various applications.
f. Use logic gates to decode any given state of a counter.
g. Design a counter that will have any specified sequence of states.
h. Use logic gates to decode any given state of a counter.
i. Determine the modulus of a counter and modify it.
j. Troubleshoot counters for various types of faults.
k. Interpret counter logic symbols that use dependency notation.

2. Learning Activities:
   a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
   b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. Unit Outline:
   a. Asynchronous (Ripple) Counters
   b. Synchronous Counters
   c. IC Synchronous Counters
   d. Analyzing Synchronous Counters
   e. Tools for Creating HTML Documents
   f. Web Development Life Cycle

H. Lesson Eight: Digital Arithmetic: Operations and Circuits

1. Learning Outcomes: Upon successful completion of this lesson the student will be able to:
   a. Distinguish between half-adders and full-adders.
   b. Be able to represent signed numbers.
   c. Use 2’s complement in addition and subtraction.
   d. Use full-adders to implement multi-bit parallel binary adders.
   e. Build and troubleshoot an addition and subtraction circuit.
   f. Identify negative numbers generated by subtraction circuits.
   g. Understand hexadecimal arithmetic.
   h. Be aware of carry propagation in math circuits.

2. Learning Activities:
   a. Research and discuss the topics of the Lesson in class and in an online collaborative discussion forum (C7, C8, C9, C15, C18, F1, F9, F10, F13)
   b. Perform skills and functions in the section (C1, C5, C7, C8, C9, C16, C18, F1, F9, F10, F13)

3. Unit Outline:
   a. Design of a Full Adder
   b. Representing Signed Numbers
   c. Two’s-Complement System
   d. Parallel Binary Adder
   e. Binary Addition and Subtraction
   f. Hexadecimal Arithmetic
   g. Carry Propagation