

## Course Syllabus: CFAA Course 4 – Life Safety Systems Electronics

### Course Structure

The curriculum is organized into three core modules across 14 chapters:

- **Part A: Analog Electronics** (Chapters 1–6): Semiconductor physics, power regulation, and operational amplifiers.
- **Part B: Digital Electronics** (Chapters 7–9): Logic families, numbering systems, and memory components.
- **Part C: Life Safety Applications** (Chapters 10–14): Integration of components into addressable loops and control unit monitoring.

### Weekly Schedule Summary

| Weekend          | Day              | Chapters Covered | Module                                    |
|------------------|------------------|------------------|---|
| <b>Weekend 1</b> | Saturday (Day 1) | Chapters 1 & 2   | Part A: Foundations of Analog Electronics |
|                  | Sunday (Day 2)   | Chapters 3 & 4   | Part A: Foundations of Analog Electronics |
| <b>Weekend 2</b> | Saturday (Day 3) | Chapters 5 & 6   | Part A: Completion                        |
|                  | Sunday (Day 4)   | Chapters 7 & 8   | Part B: Digital Electronics               |
| <b>Weekend 3</b> | Saturday (Day 5) | Chapters 9 & 10  | Part B & Part C Transition                |
|                  | Sunday (Day 6)   | Chapters 11–14   | Part C: Life Safety Applications          |

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### 2. Daily Schedule Template

The following agenda applies to all six days of instructional delivery.

| Time Slot     | Activity                      |
|---------------|-------------------------------|
| 09:00 – 10:45 | Morning Instructional Session |
| 10:45 – 11:00 | Morning Break                 |
| 11:00 – 12:00 | Mid-Day Instructional Session |
| 12:00 – 13:00 | Lunch Break                   |

|               |                                      |
|---------------|--------------------------------------|
| 13:00 – 14:30 | Afternoon Instructional Session      |
| 14:30 – 14:45 | Afternoon Break                      |
| 14:45 – 16:00 | Review, Practical Exercises, and Q&A |

### 3. Weekend 1: Part A – Foundations of Analog Electronics

#### Day 1 (Saturday): Chapters 1 & 2

#### Chapter 1: Diodes, Rectifiers, and Regulators

- **Semiconductor Atomic Structure:** Differentiate between conductors and insulators. Conductors contain 1, 2, or 3 **valence electrons** in their outer shells. Insulators contain 5 or more valence electrons.
- **P-N Junction Designation:** Identify **N-type material** (negative terminal) as the **cathode** and **P-type material** (positive terminal) as the **anode**.
- **Technical Characterization:** Designate horizontal axis voltage values as  $V_p$  and vertical axis current values as  $I_p$ .
- **Maximum Reverse Voltage:** Master the strict definition: the value of reverse voltage beyond which there is a significant increase in reverse current.
- **Zener Diode Regulation:** Calculate "peak shaving" in single Zener circuits. A 10-volt peak half-wave is shaved to exactly **8.2 volts** at the load.
- **Testing Procedures:** When testing a diode, you **must** use the resistance scale which exhibits the **diode symbol**. This ensures the meter applies adequate voltage to overcome the junction barrier.

#### Chapter 2: Bipolar Transistors

- **Transistor Charge Carriers:** Identify and differentiate between the two types of carriers: the **electron** in the conduction band or the **hole** in the valence band that is free to carry an electric charge.
- **Operating Regions:** Demonstrate that in the **active region**, one junction is forward biased while the other junction is reverse biased.
- **Circuit Designations:** Identify the common-emitter configuration gain as  $H_{FE}$ . Designate the upper schematic in Module 2.3 as the **emitter-follower circuit**.

- **Practical Testing:** Apply the same "diode symbol" resistance scale methodology used for diodes to ensure barrier voltage is overcome during transistor junction tests.

### Day 1 Review Questions

1. What is the standard number of valence electrons found in the outer shell of a conductor?
2. Define "Maximum Reverse Voltage" exactly as it pertains to diode characteristics.
3. To test a P-N junction, why must a technician use the resistance scale exhibiting a diode symbol?

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### Day 2 (Sunday): Chapters 3 & 4

#### Chapter 3: Field Effect Transistors (FETs)

- **MOSFET Definition:** Define the Metal-Oxide Semiconductor Field Effect Transistor as having no electrical connection between the gate and the current channel.
- **JFET Advantages:** Differentiate JFETs by their operation; they are usually operated with the gate commoned through resistors with the source, ensuring the gate junction is always reverse-biased.
- **Drain Curve Legend Mastery:**
  - $I_D$ : Drain current.
  - $I_{DSS}$ : Drain current for zero bias (maximum current through JFET).
  - $V_{DS}$ : Voltage between drain and source.
  - $V_{GS}$ : Voltage between gate and source.
  - $V_P$ : Pinch-off voltage.
  - $V_{BR}$ : Breakdown voltage.
  - **Ohmic Region:** The region where the ohmic value of the channel is varied by gate bias.

#### Chapter 4: Power Supplies

- **Transformer Integrity:** Identify the function of the low-voltage power transformer. It converts **120 volts AC to low-voltage AC**. It does NOT produce DC; the subsequent in-line rectifier and filter handle the AC-to-DC conversion.

### Day 2 Review Questions

1. Does a MOSFET gate have a sliding contact or a direct electrical connection to the channel?
2. A plug-in low-voltage power transformer for a fire panel converts 120V AC into what specific type of voltage?
3. Define the "Ohmic Region" of a JFET drain curve.

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## 4. Weekend 2: Part A Completion and Part B

### Day 3 (Saturday): Chapters 5 & 6

#### Chapter 5: Operational Amplifiers

- **Technical Definition:** An **Op-Amp** is a DC-coupled high-gain amplifier with a differential voltage input and a single voltage output.
- **Comparator and Regulator Functions:** Contrast circuits that compare two similar identities (voltages) against those used for stabilization.
- **Oscillators:** Utilize the **Wien** bridge oscillator (correct spelling required).
- **Wien Bridge Modification:** Per Figure 2, implement the physical addition of a **resistor** into the feedback loop/input of the op-amp to enable oscillation.

#### Chapter 6: Analog Electronics Applications

- **Inductive-Load Protection:** Apply diode commutation for **voltage spikes** created by collapsing fields. This is critical for protecting circuits against back-EMF from relay coils and solenoids.
- **Supervisory Condition Monitoring:** Analyze the "end-of-line" (EOL) resistor as a **biasing resistor** for a transistor located back in the control unit.

### Day 3 Review Questions

1. In an LSS control unit, what is the electronic purpose of the end-of-line resistor in a supervisory circuit?

2. What specific electrical phenomenon does a commutation diode protect against in inductive-load circuits?

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## Day 4 (Sunday): Chapters 7 & 8 (Digital Electronics)

### Chapter 7: Numbering Systems

- **Base Systems:** Command of Binary (Base 2), Hexadecimal (Base 16), and **BCD (Binary Coded Decimal)**.
- **BCD Parameters:** One digit represents a value up to 10 units using **4 bits** (0000 to 1001).
- **Hexadecimal Conversion Practice:** Convert **3BE2** to decimal.
  - Identify coefficients: B=11, E=14.
  - Calculate:  $(3 \times 16^3) + (11 \times 16^2) + (14 \times 16^1) + (2 \times 16^0)$ .
  - Result:  $12,288 + 2,816 + 224 + 2 = \{15,330\}$ .

### Chapter 8: Logic Gates

- **Logic Families and Parameters:** Evaluate TTL and CMOS based on the following operational criteria:
  - **Maximum voltage rating** and input/output voltages.
  - **Fan-out** (Maximum output current).
  - **Propagation delay time** (Time to change from input to output signal).
  - **Noise Margin** and Clock Frequency.

| Family        | Year | Technical Description   |
|---------------|------|---|
| <b>TTL</b>    | 1968 | Bipolar Junction Transistor (BJT) logic. Standard industry power. |
| <b>HC/HCT</b> | 1975 | High-speed CMOS; HCT is TTL-compatible.                           |
| <b>AC/ACT</b> | 1985 | Advanced CMOS; ACT is TTL-compatible; lower power dissipation.    |
| <b>LVC</b>    | 1993 | Low-voltage CMOS (3.5V operation).                                |

|            |      |  |
|------------|------|--|
| <b>AHC</b> | 1996 | Advanced High-speed CMOS; used in modern fire control units. |
|------------|------|--|

- **Flip-Flops and Memory:**

1. **RS Flip-Flop:** The simplest memory element. Identify the **Forbidden State** in NAND implementations when both SET and RESET are 0.
2. **JK Flip-Flop:** Common toggle input. Differentiate **Non-synchronous inputs** (PRESET and CLEAR) which overwrite the synchronous inputs (J, K, and Clock).
3. **D Flip-Flop:** Known as the **Data Latch** or Delay Flip-Flop.
4. **T Flip-Flop:** A toggle flip-flop obtained by connecting J and K inputs.

#### Day 4 Review Questions

1. In a NAND-based RS Flip-Flop, what is the result of applying a logic 0 to both SET and RESET?
2. Which inputs on a JK Flip-Flop will overwrite the synchronous clock inputs?

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### 5. Weekend 3: Digital Systems and Life Safety Applications

#### Day 5 (Saturday): Chapters 9 & 10

##### Chapter 9: Digital System Components

- **Registers:** Identify **Shift Registers** as the mechanism used to manipulate digital information from Serial-in to Parallel-out, a process vital for feeding event data to printers in fire panels.
- **Counters:** Differentiate between **Asynchronous (Ripple)** counters, where the clock is only applied to the first flip-flop, and **Presettable** counters that can be pre-loaded with data.
- **Multiplexers (Mux):** A device that selects one of several signals and forwards it to a single output.
- **Language Defined:**
  - **Encoder:** Converts information to another format to increase transmission speed or reduce wiring.
  - **Decoder:** Performs the reverse operation of an encoder.

- **Summer Op-Amp:** An op-amp circuit used to add or sum two or more signal voltages.

## Chapter 10: System-Level Monitoring Synthesis

- **Integration Analysis:** Analyze how previous components converge to form a supervised LSS:
  - **Diodes** provide signal steering and polarity protection in notification appliance circuits.
  - **Transistors** act as electronic switches for internal control and supervisory relays.
  - **Logic Gates and AHC CMOS** handle addressable polling and high-speed data processing.
  - **Mux/Demux** allow hundreds of zone indications to be transmitted to a remote annunciator over a simple two-wire circuit.

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## Day 6 (Sunday): Part C Integration and Final Review

### Chapters 11-14: System Integration

- **Control Unit Architecture:** Study the internal processing logic of modern fire alarm control units.
- **Field Device Electronics:** Analyze the internal circuitry of smoke detectors and pull stations, focusing on how they transmit status (Normal, Alarm, Trouble) to the panel.

### Final Course Review: Critical Technical Takeaways

- **Analog:** A method of describing values in continuously variable amounts.
- **Digital:** A method using discrete amounts (1 and 0).
- **Truth Table:** A chart that contains possible input parameters of a circuit, with resultant outputs.
- **Critical Errata Reminder:**
  - Conductance is determined by **1, 2, or 3 valence electrons**.
  - Transformers convert **120V AC to Low-Voltage AC**.

- Zener diodes facilitate **Peak Shaving** (e.g., to 8.2V).
- Supervisory EOL resistors function as **Biassing Resistors** for control unit transistors.
- Inductive protection is for **Voltage Spikes** from collapsing fields.

### **Final Review Questions**

1. Define a "Truth Table" as it applies to logic circuit testing.
2. In a fire alarm printer interface, what type of digital register is used to convert serial data to parallel?
3. Is a "Summer Op-Amp" used for power regulation or for combining multiple signal voltages?