

ECE 215/S – Principles of Electronic Cyber Warfare

Block 3: Communication Systems, Radar, and Electronic Warfare

Lesson 41: Final Exam Review

Department of Electrical and Computer Engineering
United States Air Force Academy

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Where We Are Going

This is the **last lesson of the semester**. By the end of it you will have:

- A clear picture of what the final covers, how it is scored, and what is allowed on your desk
- Worked a **Block 2 ADC chain**, from sampling rate to quantization error — Lesson 39 worked Blocks 1 and 3
- Named three conventions, all printed on the equation sheet, that cost points every semester
- Asked whatever is still unresolved — the rest of the period is yours

Have your equation sheet and returned quizzes out. Today is a working session, not a lecture. The **Project 3 Individual Questions** are due **Thu 10 Dec, 2359** (L41 T-day).

The Final at a Glance

- **Finals week**, set by the registrar — handwritten and proctored. **Individual effort**, one time, **no retakes**
- Worth **30%** of the course grade. Scored **1** / **0.5** / **0** on each objective-tagged part: the right framework, shown clearly, is worth at least half
- **Authorized resources**, as the exam's cover prints them: "Any calculator, pencil/pen, the provided equation sheet, and scratch paper, if needed. No course materials, websites, or external materials may be referenced during the exam."
- So **bring** a calculator you know how to use and something to write with. The equation sheet comes with the exam. **No notes and no slides** — this is not the midterm
- Also on the cover: show all work; put answers **in the boxes**; **engineering notation with units** (12.43 μV) or lose points; no fractions or square roots; **completely label** every diagram

Name the framework before you touch the arithmetic. That is where the points are.

What the Final Covers

All three blocks. Every objective is fair game:

Block 1 — 1.1–1.8

- DC and AC analysis
- Circuit protection
- Reactive and apparent power
- Efficiency
- Transformers, converters
- Decision matrices

Block 2 — 2.1–2.8

- Frequency domain, bandwidth
- Ideal and analog filters
- Impedance
- ADC and signal conditioning
- Digital logic
- Finite state machines

Block 3 — 3.1–3.9

- AM and demodulation
- Antennas
- Line of sight
- Friis, radar range
- Pulse-Doppler
- SNR and jamming

Three Conventions That Cost Points

All three are printed on the equation sheet, and all three differ from what you may find online. Use the sheet's form, not habit:

- **Nyquist is $f_s \geq 2f_{high}$.** Greater than *or equal to*. Sampling exactly at $2f_{high}$ satisfies the criterion
- **Quantization truncates.** $QL = \text{floor}(EL)$ — never round to nearest. This is why QE is never negative and at most ΔV
- **Modulation index is $\alpha = \max(\textbf{message})/B$.** A_m/B is only the single-tone special case

Know the sheet before you sit down.
Spend your first two minutes reading the whole exam.

Worked Review Problem — Block 2

A pressure transducer feeds an **8-bit ADC**. The ADC is configured for $V_{min} = 0$ V and $V_{max} = 5$ V. The transducer's output contains frequency content up to **12** kHz.

1. What is the minimum sampling rate that avoids aliasing?
2. What is the voltage resolution ΔV?
3. The transducer outputs $V_{in} = 3.30$ V. Find the expected level, the quantized level and its 8-bit binary code, the quantized voltage, and the quantization error.

Everything you need is on the equation sheet. Work it before the next slide.

Worked Review Problem — Solution

1. **Sampling rate.** Nyquist: $f_s \geq 2f_{high} = 2(12\,\text{kHz}) = 24\,\text{kHz}$
2. **Resolution.** An 8-bit converter has $2^8 = 256$ levels:

$$\Delta V = \frac{V_{max} - V_{min}}{2^b} = \frac{5 - 0}{256} = 19.53125\,\text{mV} \quad \text{(keep every digit for step 3)}$$

3. **Converting 3.30 V.**

$$EL = \frac{V_{in} - V_{min}}{\Delta V} = \frac{3.30 - 0}{0.01953125} = 168.96$$

$$QL = \text{floor}(168.96) = \mathbf{168} = 10101000_2 \quad \text{(truncate — do not round to 169)}$$

$$V_{quant} = QL \cdot \Delta V + V_{min} = 168(0.01953125) + 0 = 3.28125\,\text{V}$$

$$QE = V_{in} - V_{quant} = 3.30 - 3.28125 = 18.75\,\text{mV}$$

Check: $0 \leq QE \leq \Delta V$. A **negative** QE means you rounded up instead of truncating.

Your Turn

A sensor feeds a **10-bit ADC** configured for $V_{min} = -2\,\text{V}$ and $V_{max} = +3\,\text{V}$. The sensor's signal contains content up to **8** kHz.

1. What is the minimum sampling rate?
2. What is ΔV?
3. For $V_{in} = 1.15\,\text{V}$, find EL, QL and its 10-bit binary code, V_{quant}, and QE.

Watch the negative V_{min}. It appears three times — in ΔV, in EL, and in V_{quant}.

The Days Before the Exam

- **Work problems, do not reread slides.** Recognition is not recall — the practice problems and your returned quizzes are the highest-value material you have
- **Work them with the equation sheet in front of you**, so you learn its layout rather than the equations
- **Go back to what you scored a 0 on.** Every quiz retake you took is a problem someone already told you how to fix
- **EI is available right up to the exam.** Come with a specific problem, not “can we review Block 2”

Most lost points are method errors, not arithmetic. Practice choosing the framework.

Open Q&A

The rest of the period is yours.

- Bring up any objective you are still unsure of
- Any practice problem, quiz problem, or midterm problem is fair game
- If nobody has a question, we will work another problem from the block you collectively scored lowest on

Wrap-Up

Today:

- The final covers all three blocks, is handwritten and proctored, and is scored 1 / 0.5 / 0
- **On your desk:** a calculator, a pencil or pen, the provided equation sheet, and scratch paper — nothing else
- Nyquist uses $\geq$, quantization truncates, and α uses $\max(\text{message})$
- Framework first, arithmetic second

Next:

- **Dean's Study Day is 11 December.** Finals run **14–17 December**
- Your final exam period is set by the registrar — confirm yours

Good luck. It has been a pleasure teaching you.