FUNDAMENTALS OF ENGINEERING (FE)

ELECTRICAL & COMPUTER

YOUR COMPLETE GUIDE TO THE FE EXAM & EIT LICENSE

Everything you need to know to prepare for the NCEES FE Electrical & Computer exam, **earn your Engineer in Training (EIT) designation,** and take your first confident step toward the PE license.

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Founder, ShaiLearning.com

Aligned to the NCEES FE Electrical & Computer CBT Exam Specifications | NCEES Examinee Guide

November 2025

📌 **For domestic candidates (United States) AND international candidates worldwide.**
Visit shailearning.com to learn more about the mentorship program and to book a 1-on-1 call.

A Personal Note to You

Before we get into exam knowledge areas, testing windows, and everything you need to know about the Fundamentals of Engineering (FE) examination, let me take a moment to be real with you. Because this guide is not just a document I put together — it represents a journey I lived.

I grew up in Ghana, West Africa. Nobody in my circle had walked the path to a U.S. Professional Engineer (PE) license. I had no mentor, no roadmap, and frankly, no idea how complicated — and how achievable — this process actually was. I figured it out through trial and error and a lot of late nights. My first FE exam attempt? I failed, and the memories of November 2021 still stayed with me. I will tell you the truth: that stung. But I came back. I studied smarter, not just harder, and on February 19, 2022, I passed. That day changed everything for me.

Then came the PE exam, which I passed on the first attempt. Then I waited for 4 years to accumulate professional engineering experience. I moved ahead to obtain licenses in New Jersey, Illinois, and Pennsylvania. Grateful to my references, whose support I will continue to be thankful for. And through all of it, one thought never left me — nobody should have to figure this out completely alone.

That is why ShaiLearning.com exists. And that is why this guide is made for you.

Whether you are a senior about to graduate from an ABET-accredited school in the United States, an engineer in Nigeria or Turkey who just discovered you can take the FE exam locally, or someone who immigrated to the U.S. and is trying to get your international credentials recognized, I wrote this for you. All of you.

This guide covers all 17 knowledge areas of the FE Electrical & Computer exam exactly as the National Council of Examiners for Engineering and Surveying (NCEES) has specified them. It also covers registration, exam day preparation, what happens after you pass, and how the journey continues toward the PE license. We will focus on building your foundation of understanding before we go into the technical details. And for those outside the United States, we will walk through the additional pathway steps, so nothing is left to guesswork. I have been through it all.

You are not behind. You are exactly where you need to be. Let's go.

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Chapter 1: Understanding the FE Exam — The Big Picture

The Fundamentals of Engineering (FE) exam is the first official milestone on the path to becoming a licensed Professional Engineer in the United States. It is administered by the National Council of Examiners for Engineering and Surveying, known as NCEES, and it is the credential that officially opens the door to the Engineer in Training designation.

Let me be straightforward about what this exam is and what it is not. The FE is not a test of whether you are a great or 'smart' engineer. It is a test of whether you have a working foundation across the core knowledge areas of your engineering discipline. It is broad by design, covering 17 areas of knowledge. It touches mathematics, science, ethics, engineering economics, circuits, power, signals, digital systems, software, and more — all in a single sitting. That breadth is intentional. The NCEES designed this exam to establish a **minimum** competency standard, and passing it says to the world: this person has the fundamentals.

Why Getting This Right on the First Attempt Matters

In the 2023–24 testing year, NCEES administered over 53,000 FE exams across all disciplines. For the Electrical & Computer discipline specifically, first-time pass rates for candidates from ABET-accredited programs have been in the 69–71% range. That means roughly one in three candidates fails on the first try. This is not because the exam is impossible. It is because many candidates underestimate the breadth of what is being tested and do not study with a clear structure.

Repeat takers historically have lower pass rates than first-timers. That single data point should motivate you to prepare well before your first attempt rather than plan to retake it. Our mentorship program at ShaiLearning.com is designed specifically to help you pass on the first try.

Key Statistic

FE Electrical & Computer first-time pass rate (ABET-accredited candidates, 2024): approximately 71%. Source: NCEES Squared 2024 Annual Report. Visit shailearning.com for updated stats and mentorship support.

The Seven FE Disciplines

NCEES offers the FE exam in seven discipline-specific versions. This guide is written exclusively for the Electrical & Computer discipline. Here is a quick overview so you can confirm you are in the right place:

Discipline	Who It Is For	2024 Pass Rate
Civil	Civil and structural engineers	~68%
Mechanical	Mechanical engineers	~73%
Electrical & Computer	EE, ECE, Computer Engineering	~71%
Chemical	Chemical and process engineers	~73%
Environmental	Environmental engineers	~73%
Industrial & Systems	Industrial engineers	~78%
Other Disciplines	Broad or interdisciplinary engineers	~63%

What the EIT Designation Means for Your Career

When you pass the FE exam, you are one step away from earning the Engineer in Training (EIT) designation — also called Engineering Intern (EI) in some states. You have to submit an application to a state's Board for determination and approval. For instance, in states like New Jersey, you need to submit a separate application to your state board to receive your official EIT certificate. This designation does several important things:

- It officially qualifies you to begin accumulating the supervised engineering experience required before you can sit for the PE exam
- It signals to employers and recruiters that you are on a professional licensure track — a serious signal in government, infrastructure, and utility sectors
- In certain roles, especially in public agencies, the EIT credential unlocks specific job titles and pay grades
- It starts the clock on your four-year (at most) experience requirement toward the PE license

From Shai

On February 19, 2022, I passed the FE exam on my second attempt. My first attempt was in November 2021 — I failed, and it hurt. But I studied differently the second time. I approached it with structure and strategy, not just volume. The day I got that pass notification, the feeling was real. It was the beginning of everything that came after. If you are reading this and you have already failed once — do not let that stop you.

Come back better.

Chapter 2: Who This Exam Is For — Domestic & International Eligibility

One of the most common questions I receive from engineers outside the United States is: does this even apply to me? The short answer is almost always yes. The FE exam is open to a much wider audience than most people realize, and the international pathway — while it has extra steps — is absolutely walkable. I have walked it myself.

You can also check your eligibility quickly at **ShaiLearning.com** before diving into the details here.

U.S.-Based Candidates

If you are studying at or have graduated from an EAC/ABET-accredited engineering program in the United States, you are in the primary audience NCEES designed this exam for. The eligibility rules are:

- Students within two full-time semesters of graduating from an ABET-accredited program — this is actually one of the best times to take the exam, while the material is still fresh
- Recent graduates holding a Bachelor of Science in engineering from an accredited program
- Graduate students currently enrolled in a master's or PhD engineering program
- Non-student professionals holding a qualifying engineering or related science degree

Each U.S. state has its own licensing board, with slightly different interpretations of eligibility. Always confirm your state's specific rules at ncees.org/licensing-boards/, as shown in Figure 1. Some states, California, for example have unique provisions that differ from the NCEES standard.

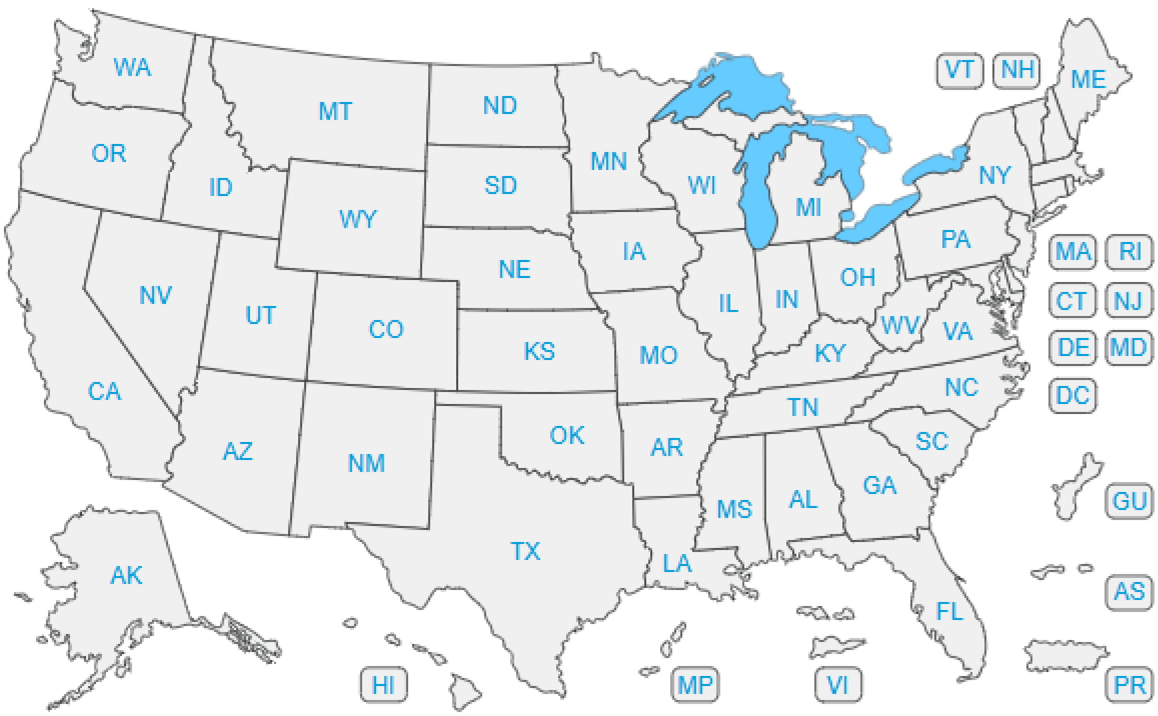


Figure 1: United States Licensing Boards

International Candidates — You Belong Here Too

This section is personal to me because I was once there, even though I wrote my exam in the United States, there are some processes that still apply from international perspective. I had to figure out a lot from scratch. Nobody handed me a clear guide, despite speaking with couple of people. So, I am going to give you what I wish I had.

The FE exam is available internationally, and a U.S. PE license is achievable from virtually any country if you follow the right steps. Let me break it down.

Step 1: Check Whether Your Degree Is ABET-Accredited

NCEES and most U.S. state boards prefer degrees from EAC/ABET-accredited programs. If your program is not ABET-accredited — which is common outside the United States — you will need to go through the NCEES Credentials Evaluation process or as specified by your state Board. This service reviews your academic background and determines whether it is substantially equivalent to what ABET requires. The evaluation fee as of 2025 is $400 for international candidates. Always confirm the current fee at ncees.org.

Note

ABET program search: www.abet.org | NCEES Credentials Evaluation: ncees.org/licensure/international-professionals/

Countries Where You Can Take the FE Exam Without Traveling to the U.S.

This is something many international engineers do not know. You do not have to fly to America to take the FE exam. NCEES has formal agreements with testing partners in multiple countries:

Country / Region	Key Notes
Canada (Alberta)	Administered through APEGA. You must contact APEGA first, then register with NCEES. FE exam fee: $250.
Saudi Arabia	Available at Pearson VUE centers. Register through MyNCEES directly.
United Arab Emirates	Pearson VUE centers in Abu Dhabi and Dubai. Register through MyNCEES.
Egypt	Pearson VUE centers available. Standard NCEES exam fee applies.
Turkey	Pearson VUE centers available. Register through MyNCEES.
Japan	NCEES has a longstanding agreement with JPEC. Strong track record since 2006.
United Kingdom	CEng + IntPE holders may qualify for U.S. licensure via Mutual Recognition Agreement with exams waived.
50+ other nations	Pearson VUE operates in over 180 countries. Check: home.pearsonvue.com/ncees

Washington Accord Countries — A Smoother Path

If your engineering degree comes from a country whose accreditation body is a signatory to the Washington Accord, the NCEES credentials evaluation process tends to go more smoothly because the equivalency of your program standards is already mutually recognized. Washington Accord signatories include Australia, Canada, China, Hong Kong, India, Ireland, Japan, South Korea, New Zealand, Pakistan, Russia, Singapore, South Africa, Sri Lanka, Taiwan, Turkey, the United Kingdom, and others.

Moving to the United States — What You Need to Know

If you have recently immigrated to the U.S. or are planning to, your international engineering degree is not automatically recognized by U.S. state licensing boards. This is not a judgment of your qualifications — it is a standardized review process that protects the public. The NCEES Credentials Evaluation is the bridge. Once that evaluation is complete and submitted to your state board, you follow the same FE → EIT → PE path as any domestic candidate.

From Shai

When I went through the credential evaluation process, I was nervous. I did not know if my Ghanaian degree would hold up. It did. Once I understood that the evaluation was just a comparison process — not a judgment of my worth as an engineer — I relaxed and followed each step. I encourage you to do the same. The process exists to open doors, not close them. Book a 1-on-1 call with me at shailearning.com if you want to talk through your specific situation.

Chapter 3: Registering for the Exam — Step by Step

Registration has a specific sequence that must be followed in order. I have seen candidates lose their exam slot because they registered with NCEES before getting approval from their state board — which some states require first. Follow these steps exactly and in order.

Step	Action	What You Need to Know
1	Review your state board's process	Eligibility is set by each licensing board, not NCEES. Visit ncees.org/licensing-boards/ and find your state. Some boards require you to apply and receive approval before you can even register with NCEES. Do not skip this.
2	Create your MyNCEES account	Go to ncees.org and create a free account. Your legal first and last name must match your government-issued ID exactly — the name on your account is used for your appointment confirmation letter.
3	Register and pay for the FE exam	Log in to MyNCEES, select 'Register for an exam,' and follow the instructions. Pay the FE exam fee directly to NCEES online via MasterCard, VISA, or American Express. This step registers you but does not yet schedule your exam.
4	Request accommodations if needed	If you have a disability covered under the Americans with Disabilities Act (ADA), indicate this during registration. Accommodation requests are managed through Pearson VUE. Do not wait until after registration to flag this.
5	Receive your Authorization to Test (ATT)	Once your licensing board approves you and NCEES processes your registration, you will receive an email titled 'NCEES Exam Ready to Schedule.' This is your ATT. You then have 12 months to take the exam.
6	Schedule your appointment at Pearson VUE	Log in to MyNCEES, select the 'Schedule' button, and follow the instructions. You will receive an appointment confirmation email from Pearson VUE. If you do not receive this email, your exam has not been scheduled.

⚠ Important

You must schedule at least one business day before your exam date. Pearson VUE test centers fill up on a first-come, first-served basis. The April–June window is always the busiest. Schedule as early as possible once you receive your ATT.

Testing Windows — When You Can Sit

The FE exam runs year-round across four testing windows. Per NCEES policy, you may sit for the exam once per testing window and **no more than three times within any 12-month period**. Some state boards have more restrictive policies — check yours.

Testing Window	Best For
January – March	Recent fall semester graduates; strong start to the year
April – June	Highest volume window — spring graduates; schedule early
July – September	Summer graduates and focused retakers
October – December	Year-end completions; strategic for those building up preparation time

Fees — What to Expect

Exam / Fee Item	Amount (Effective January 1, 2024)
Fundamentals of Engineering (FE)	$225
International scheduling fee (non-Canada foreign entity)	$25 nonrefundable
Cancellation or rescheduling fee (Pearson VUE)	$50 online; additional fees if by phone
Registration cancellation refund	NCEES fee less $50 administrative fee
NCEES Credentials Evaluation (international candidates)	$400 (confirm current amount at ncees.org)

NCEES-Approved Calculators

The FE exam is closed book with an electronic reference. You may bring only one calculator, and it must be from the NCEES-approved list. These are the approved models for 2025 and 2026 exams:

- Casio: All fx-115 and fx-991 models — the model name must contain 'fx-115' or 'fx-991'
- Hewlett Packard: HP 33s and HP 35s only — no other HP models
- Texas Instruments: All TI-30X and TI-36X models — the model name must contain 'TI-30X' or 'TI-36X'

Calculator covers and spare calculators must be stored in your assigned locker at the test center. This is strictly enforced. The approved calculator list is reviewed annually — always verify at ncees.org before your exam. I personally recommend the Casio fx-991 series. It is affordable, widely available internationally, and covers everything the exam requires.

🔗 **Want to go deeper?**

For a personalized registration walkthrough based on your specific state or country, book a 1-on-1 call at shailearning.com. We will go through your situation step by step.

Chapter 4: The Exam Format — What to Expect on Test Day

Knowing exactly what exam day looks like removes one layer of anxiety before you even walk through the test center doors. Let me walk you through everything.

The Exam at a Glance

Parameter	Detail
Format	Computer-Based Test (CBT) — fully electronic, no paper
Total questions	110 questions
Total appointment time	6 hours
Tutorial (start of session)	Included in the 6 hours — covers how to navigate the CBT system
Optional break	25 minutes — scheduled between the two exam sessions
Exam sessions	Two sessions of 55 questions each
Net testing time	Approximately 5 hours and 20 minutes of actual question time
Time per question	About 2.9 minutes average if distributed evenly — but pace strategically
Reference material	NCEES FE Reference Handbook — provided digitally on screen, searchable
Outside materials	None permitted — closed book exam
Units	Both SI and U.S. Customary System (USCS) are used throughout
Score reporting	Pass or Fail — results typically available within 7–10 business days via MyNCEES

What Happens When You Arrive

Arrive at the Pearson VUE test center with enough time to complete the check-in process without rushing — I recommend arriving 30 minutes early. You will need to present a valid government-issued ID with your name exactly as it appears on your appointment confirmation. **If there is a discrepancy, you may not be allowed to take the test and your fees will not be refunded.**

You will be required to store all personal belongings — including your phone, wallet, keys, and calculator case — in an assigned locker. Only your approved calculator, your ID, and any provided materials are allowed into the testing room. Pearson VUE staff will conduct a security check before you enter.

The FE Reference Handbook — Your Best Friend in the Exam Room

Because this is a closed-book exam, the NCEES FE Reference Handbook is your only reference during the test. It is displayed electronically on your exam screen and is searchable. This is not a disadvantage — it is actually a powerful tool if you know how to use it.

Download the handbook for free from your MyNCEES account well before exam day and study it consistently throughout your preparation. Know where each topic section is. Know what formulas and tables are available to you. During the exam, you will not have time to discover the handbook's layout for the first time. Familiarity with the handbook is itself a preparation strategy.

> **Pro Tip**
> Spend at least two to three study sessions doing nothing but navigating the FE Reference Handbook. Find every section that corresponds to each of the 17 knowledge areas. Build a personal map of the handbook so that on exam day, you can locate what you need in seconds, not minutes.

Exam Results and What They Mean

Results are reported as Pass or Fail only — NCEES does not publish a numerical score. You will receive an email notification within 7–10 business days directing you to view your results in MyNCEES. If you pass, the notification will include instructions for your licensing board. If you do not pass, you will receive a diagnostic report showing your performance across each of the 17 knowledge areas — use that report as your roadmap for your next attempt.

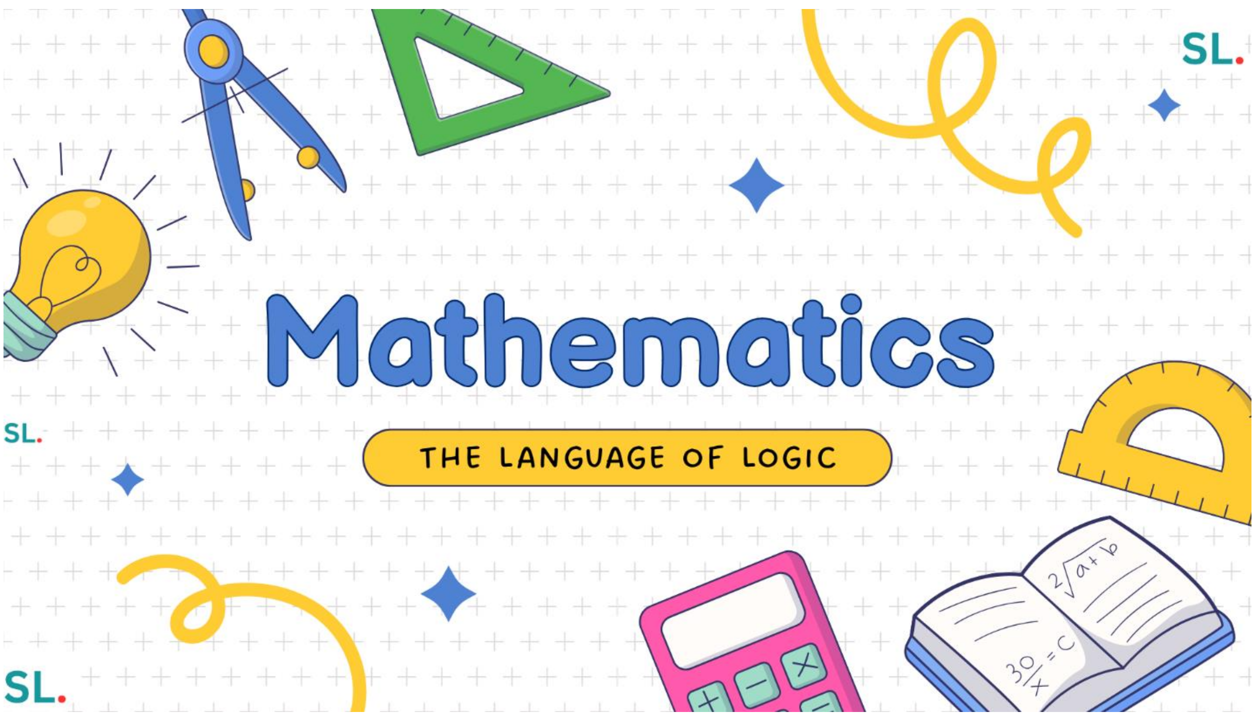
> **Want to go deeper?**
> Head to shailearning.com/fe-electrical-guide for supplementary study resources and to join the mentorship waitlist. If you have questions about the exam format or need help building a study plan, book a 1-on-1 call with Shai directly.

Chapter 5: Knowledge Area 1 — Mathematics

Questions on exam: 11–17 | This is one of the two highest-weighted areas on the entire exam.

Mathematics is the language of engineering. Every other knowledge area on the FE exam builds on your mathematical foundation. This is not a topic you can skim over because you feel you remember it from university. The exam tests applied mathematics — the kind used to solve circuit problems, analyze signals, and model system behavior.

The good news is that the FE Reference Handbook provides the formulas. What you need to bring is the ability to recognize which mathematical tool a problem is asking for and apply it correctly under time pressure.



What NCEES Tests in Mathematics

A. Algebra and Trigonometry

This includes operations with polynomials, solving systems of equations, working with logarithms and exponentials, and applying trigonometric identities. These appear throughout the exam, particularly in circuit analysis and signal processing problems.

B. Complex Numbers

Complex numbers are foundational for AC circuit analysis. You need to be fluent in rectangular and polar forms, how to convert between them, and how to perform arithmetic operations on complex quantities. The entire concept of phasors — used in AC analysis — is built on complex number representation.

C. Discrete Mathematics

This covers logic, set theory, and counting techniques. It is most relevant to the Digital Systems and Software Engineering knowledge areas later in the exam.

D. Analytic Geometry

This includes lines, curves, and geometric shapes described algebraically. These show up in graphical analysis of system responses and filter characteristics.

E. Calculus — Differential, Integral, Single-Variable, Multivariable

Calculus is used throughout the exam. Derivatives describe rates of change — think of how current relates to voltage across a capacitor, or how voltage relates to current through an inductor. Integrals compute accumulated quantities — energy, charge, signal area. Multivariable calculus becomes relevant in electromagnetics.

F. Ordinary Differential Equations

ODEs are the mathematical language of circuit transient behavior. When a capacitor charges or an inductor stores energy, the behavior over time is described by a differential equation. Understanding how these equations are set up — even if you solve them using Laplace transforms in practice — is essential.

G. Linear Algebra

Matrix operations, determinants, and vector analysis appear in node voltage and mesh current analysis for complex circuits, as well as in state-space representations in control systems.

H. Vector Analysis

Vector mathematics is the primary language of electromagnetics. Electric and magnetic fields are vector quantities, and understanding vector operations — dot products, cross products, gradient, divergence, and curl — is required to interpret Maxwell's equations and field behavior.

From Shai

Mathematics was the section I was most confident in going into the exam — and it was also the section that taught me the most about the importance of applied practice. Knowing the formulas is different from being able to apply them under time pressure. Practice problems are the only way to bridge that gap.

Chapter 6: Knowledge Area 2 — Probability & Statistics

Questions on exam: 4–6 | A smaller section, but worth every point.

Probability and statistics might not feel like the most exciting engineering topic, but they are deeply practical. Engineers use statistical reasoning constantly — in quality control, reliability analysis, signal noise modeling, and system design. The FE exam tests the fundamentals that underpin all of that.

What NCEES Tests in Probability & Statistics

A. Measures of Central Tendency and Dispersion

This covers mean, median, mode, and standard deviation. These are the tools engineers use to summarize data and understand how spread out a dataset is. The mean gives you the center. The standard deviation tells you how tightly the data is clustered around that center. On the exam, expect to calculate these directly from a dataset.

B. Probability Distributions

You need to understand discrete distributions like the binomial distribution, and continuous distributions like the normal (Gaussian) distribution. The normal distribution is particularly important — it appears in reliability analysis, quality control, and signal modeling. The FE Reference Handbook includes standard normal distribution tables, so your job is to know how to use them, not memorize them.

Conditional probability — the probability of an event given that another event has already occurred — is also testable here. This concept is the foundation of Bayesian reasoning and appears in communication systems as well.

C. Expected Value — Weighted Average

Expected value is the probability-weighted average of a random variable's possible outcomes. It is used in risk analysis, economic decision-making, and communication theory. If you can compute a weighted average, you can compute an expected value. The key is understanding what the weights represent — the probabilities.

Pro Tip

The Probability and Statistics section of the exam is one of the most predictable in terms of question format. The concepts are finite and well-defined. A focused two-week review of this section alone can lock in 4–6 points for you. Do not overlook it in favor of the larger sections.

Chapter 7: Knowledge Areas 3 & 4 — Ethics, Professional Practice & Engineering Economics

Ethics: 4–6 questions | **Engineering Economics:** 5–8 questions

I am combining these two knowledge areas in one chapter because they share something important: many candidates underestimate both of them and miss points that were completely available with modest preparation. Do not make that mistake.

Knowledge Area 3: Ethics and Professional Practice

A. Codes of Ethics — NCEES Model Law and Model Rules

The NCEES Model Law is the framework that most U.S. state engineering practice acts are built on. It defines what professional engineering practice is, who is authorized to do it, and what obligations a licensed engineer carries. The core principle underlying all engineering codes of ethics is this: public safety, health, and welfare come first — above client interests, above personal gain, above convenience.

The exam will test your ability to apply ethical principles to realistic scenarios. These are not trick questions. They reward candidates who have actually read and internalized what engineering ethics means in practice.

B. Intellectual Property

This covers the practical distinction between copyrights, trade secrets, patents, and trademarks. As an engineer, you need to know what each protects and what obligations and rights they create. Patent law, in particular, is increasingly relevant as engineering work becomes more innovation-driven.

C. Safety

Safety topics include electrical grounding principles, material safety data (the SDS — Safety Data Sheet system), personal protective equipment (PPE), and radiation protection basics. These are practical knowledge areas that engineers encounter in the field, and the exam tests whether you understand the fundamental concepts.

Knowledge Area 4: Engineering Economics

Engineering Economics is one of the most practical knowledge areas on the FE exam — and one that many engineering graduates feel least prepared for because it is often covered in a single semester course. However never leave anything for a second chance. A lot of practice never disappoint. That is our core strategy.

A. Time Value of Money

Money has time value — a dollar today is worth more than a dollar in the future. This principle drives all engineering economic analysis. The exam tests present value (what is a future amount worth today?), future value (what will a present amount grow to?), and annuities (equal periodic payments over time). The FE Reference Handbook provides the relevant formulas and factor tables.

B. Cost Estimation

Engineers are frequently asked to estimate project costs. The exam covers the principles of cost estimation, including how estimates are categorized by accuracy and how they are used in project decision-making.

C. Risk Identification

Risk in an economic context means uncertainty about costs or returns. The exam tests basic risk identification concepts — understanding what can go wrong and how to account for it in economic analysis.

D. Economic Analysis

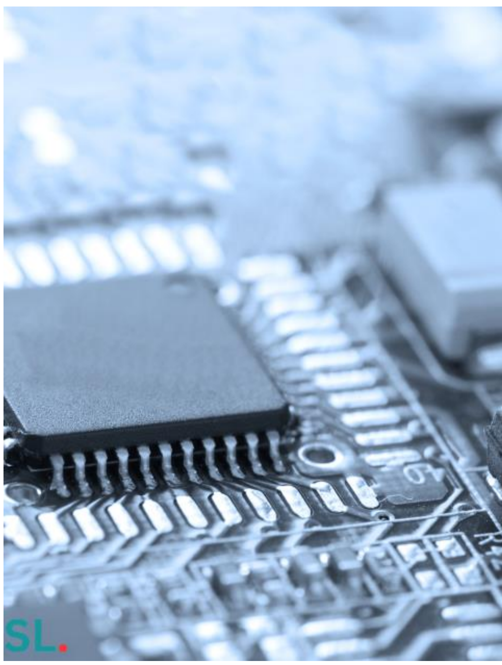
This includes cost-benefit analysis (does the benefit outweigh the cost?), trade-off analysis (comparing alternative approaches), and break-even analysis (at what point does an investment become profitable?). These are everyday tools in engineering project management.

> **From Shai**
> Ethics questions are some of the most accessible points on the FE exam if you prepare — and some of the most frustrating to miss if you skip them. I always tell my mentorship students: spend one dedicated study session on ethics. Read the NCEES Model Law. Read the NSPE Code of Ethics. Know the six fundamental canons. That preparation pays off every time. Find study resources at shailearning.com.

Chapter 8: Knowledge Area 5 — Properties of Electrical Materials

Questions on exam: 4–6 | A focused section that rewards conceptual understanding.

Before you can understand how electronic devices work, you need to understand the materials they are made from. This knowledge area covers the physical properties of the materials that form the foundation of all electrical and electronic components — from the silicon in your microprocessor to the copper in your transmission line.



What NCEES Tests in Electrical Materials

A. Semiconductor Materials

Semiconductors are the foundation of modern electronics. Silicon and germanium are the most common examples — materials that conduct electricity under certain conditions but not others. Key concepts in this section include how electron tunneling works, how charge carriers (electrons and holes) move through a material by diffusion and drift, how energy band theory explains why some materials conduct and others insulate, how doping with impurities (n-type and p-type) controls a semiconductor's behavior, and how p-n junctions form the basis of diodes and transistors.

You do not need to memorize quantum physics formulas for the FE exam. You need to understand conceptually why these phenomena occur and how they translate into the behavior of the devices you will study in the Electronics knowledge area.

B. Electrical Properties

This covers conductivity (how easily a material conducts electric current), resistivity (the inverse — how strongly a material resists current flow), permittivity (how a material stores electric field energy, relevant in capacitor design), magnetic permeability (how a material responds to magnetic fields, relevant in inductor and transformer design), and noise properties (thermal noise is generated by any resistive material at temperatures above absolute zero — understanding this is fundamental to signal processing and communications system design).

C. Thermal Properties

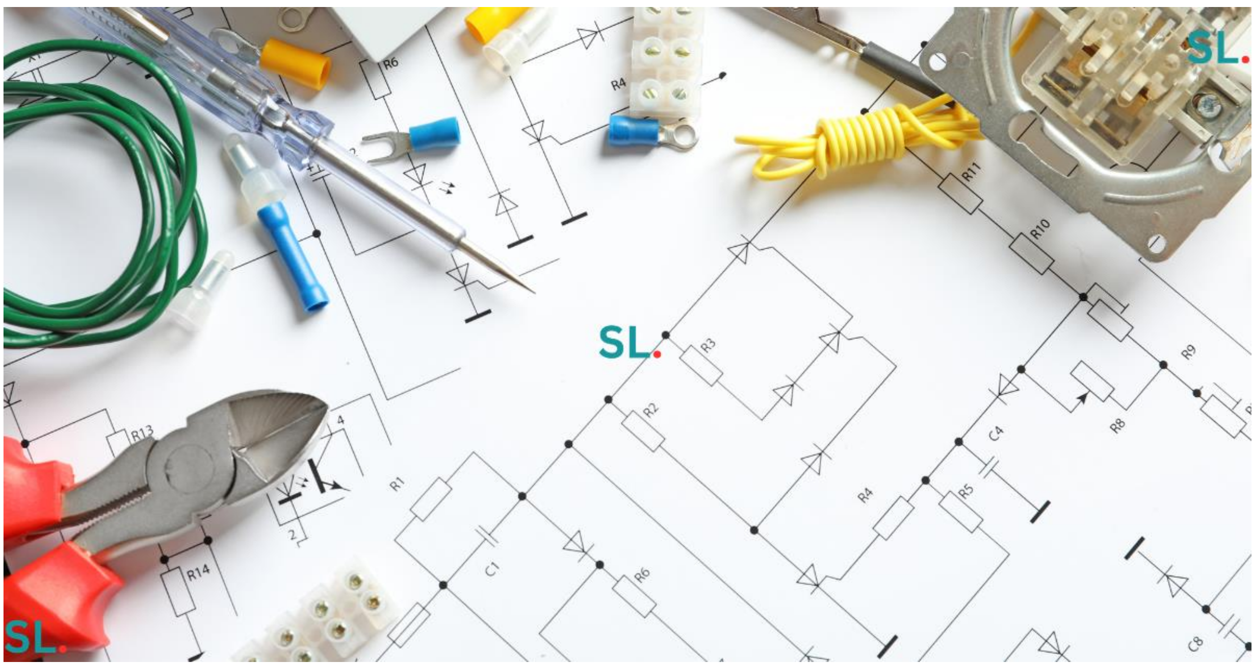
Thermal conductivity and thermal expansion are the two primary thermal properties tested here. In power electronics, heat dissipation is a major design constraint — components fail when they overheat. Thermal expansion matters in PCB design and mechanical packaging of electronic components. The FE exam expects you to understand these concepts at a level where you can apply them to practical engineering scenarios.

> **Strategic Tip**
> Material properties questions are often straightforward if you understand the physical intuition behind them. Focus on understanding why materials behave the way they do rather than memorizing specific numerical values. The FE Reference Handbook provides the data tables you need.

Chapter 9: Knowledge Area 6 — Circuit Analysis (DC and AC Steady State)

Questions on exam: 11–17 | The single most important knowledge area on this exam.

If there is one area where you absolutely cannot afford to be weak, it is circuit analysis. Tied with Mathematics as the highest question-count knowledge area, Circuit Analysis underpins almost every other technical topic on the exam. If you master circuits, Power Systems becomes more manageable. Electronics becomes more approachable. Linear Systems makes more sense. Invest heavily here.



What NCEES Tests in Circuit Analysis

A. KCL and KVL — Kirchhoff's Laws

Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) are the two fundamental laws that govern how current flows and how voltage is distributed in any circuit. KCL tells you that the sum of currents entering any node is equal to the sum of currents leaving that node — charge cannot accumulate. KVL tells you that the sum of all voltage changes around any closed loop equals zero — energy is conserved. Every circuit analysis method you use traces back to these two laws.

B. Series and Parallel Equivalent Circuits

Simplifying complex circuits into equivalent series or parallel combinations is the core circuit analysis skill. Resistors, capacitors, and inductors combine differently depending on whether they are in series or parallel. Being able to reduce a complex network to its simplest equivalent form is what makes the other analysis techniques manageable.

C. Thevenin and Norton Theorems

These two circuit theorems are tested on virtually every FE exam. Thevenin's theorem states that any linear two-terminal circuit can be replaced by a single voltage source in series with a single resistance. Norton's theorem states the equivalent using a current source in parallel with a resistance. These simplifications are powerful tools for analyzing what happens when different loads are connected to a complex source network.

D. Node and Loop Analysis

Node voltage analysis and mesh current analysis are systematic methods for solving circuits with multiple branches and loops. Node analysis assigns unknown voltages at each node and applies KCL. Mesh analysis assigns unknown currents to each loop and applies KVL. Both methods produce systems of linear equations that can be solved to find every current and voltage in the circuit.

E. Waveform Analysis

This covers the mathematical description of periodic electrical signals — their RMS values (the DC equivalent that produces the same power), average values, frequency, phase relationships, and wavelength. Understanding waveforms is the bridge between DC circuit analysis and AC circuit analysis.

F. Phasors

Phasor representation transforms sinusoidal time-domain signals into complex numbers, making AC circuit calculations as straightforward as DC circuit calculations — but in the complex number domain. A phasor captures the amplitude and phase of a sinusoidal signal. Once you think in phasors, AC circuit analysis becomes a matter of complex arithmetic.

G. Impedance

Impedance is the AC equivalent of resistance — it represents the total opposition to current flow in an AC circuit, combining the effects of resistance, capacitance, and inductance into a single complex quantity. Understanding how impedance is calculated for resistors, capacitors, and inductors individually, and how they combine in series and parallel, is the core of AC circuit analysis.

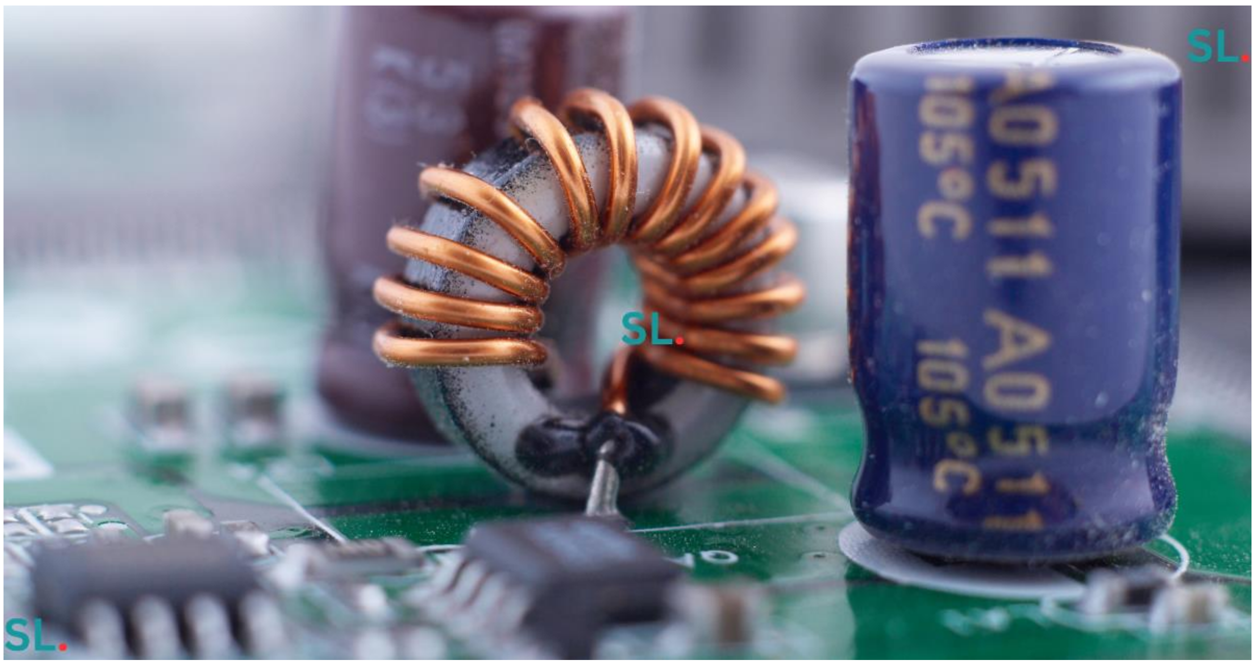
From Shai

Circuit analysis was the subject I prepared for most intensely before my FE exam — and it paid off. This is also the foundation of most PE Power exam topics. Master it now and you are building on a base that will serve you for the rest of your engineering career. For structured circuit analysis practice sessions, visit shailearning.com.

Chapter 10: Knowledge Area 7 — Linear Systems

Questions on exam: 5–8 | The mathematical bridge between circuits and control.

Linear systems theory is what happens when you take circuit analysis and extend it into the time domain and frequency domain simultaneously. This knowledge area is where circuits, mathematics, and control systems all converge.



What NCEES Tests in Linear Systems

A. Frequency and Transient Response

Every circuit or system has a characteristic way of responding to different frequencies of input signals and to sudden changes (transients). The frequency response describes how a system's output amplitude and phase change as the input frequency varies. The transient response describes how a system behaves immediately after a sudden change in input — the initial spike, the exponential decay, the settling to a new steady state. Understanding both types of response is fundamental to filter design and amplifier design.

B. Resonance

Resonance occurs in circuits containing both inductance and capacitance when the frequency of an input signal matches the circuit's natural frequency. At resonance, something interesting happens: the circuit either delivers maximum power to a load (series resonance) or presents maximum impedance (parallel resonance). Resonance is the operating principle behind radios, filters, oscillators, and many communication systems.

C. Laplace Transforms

The Laplace transform is one of the most powerful tools in electrical engineering. It converts differential equations — which describe circuit behavior in the time domain — into algebraic equations in the s-domain, making them far easier to solve. The FE Reference Handbook contains a table of Laplace transform pairs. Your job is to understand how to apply them to circuit analysis problems, not to derive them from scratch.

D. Transfer Functions

A transfer function is a mathematical description of the relationship between a system's output and its input, expressed in the s-domain using Laplace transforms. Transfer functions allow you to analyze a system's behavior — its gain, its phase shift, its poles and zeros — without solving the underlying differential equations directly every time. They are the language in which control systems are designed and analyzed.

> **Strategic Tip**
>
> Linear systems concepts connect directly to both the Signal Processing and Control Systems knowledge areas later in the exam. Time spent building a solid understanding of Laplace transforms and transfer functions is an investment that pays off across multiple exam sections.

Chapter 11: Knowledge Area 8 — Signal Processing

Questions on exam: 5–8 | Essential for communications and digital systems.

Signal processing is the discipline of extracting, transforming, and representing information from signals. It is the core of every audio system, every wireless communication system, every imaging system, and every instrumentation system. The FE exam tests the foundational concepts at a level appropriate for an engineer in training.

What NCEES Tests in Signal Processing

A. Sampling — Aliasing and the Nyquist Theorem

Converting a continuous analog signal into a discrete digital sequence requires sampling — measuring the signal's value at regular intervals. The Nyquist-Shannon theorem is the fundamental rule governing this process: to faithfully reconstruct a signal, you must sample it at a rate of at least twice its highest frequency component. If you sample too slowly, aliasing occurs — higher frequency content appears as lower frequency distortion that cannot be removed. This concept is the reason why digital audio systems sample at 44.1 kHz (covering human hearing up to about 20 kHz), and why proper anti-aliasing filters are designed before analog-to-digital conversion.

B. Analog Filters

Analog filters shape signals by selectively passing certain frequencies while attenuating others. The four fundamental types are: low-pass filters (pass frequencies below a cutoff, block above), high-pass filters (the reverse), band-pass filters (pass a range of frequencies), and band-stop or notch filters (block a specific frequency range). Every radio receiver, audio system, and sensor interface uses filters. Understanding what each filter type does — conceptually and in terms of its frequency response shape — is what the FE exam tests.

C. Digital Filters — Difference Equations and Z-Transforms

Digital filters process signals that have already been converted to discrete sequences. They are implemented in software or dedicated hardware and offer flexibility and precision advantages over analog filters. The Z-transform is the discrete-time equivalent of the Laplace transform — it converts difference equations (the digital equivalent of differential equations) into algebraic form in the z-domain. The FE exam tests your ability to work with the Z-transform conceptually and to understand the difference between FIR (Finite Impulse Response) and IIR (Infinite Impulse Response) filter structures.

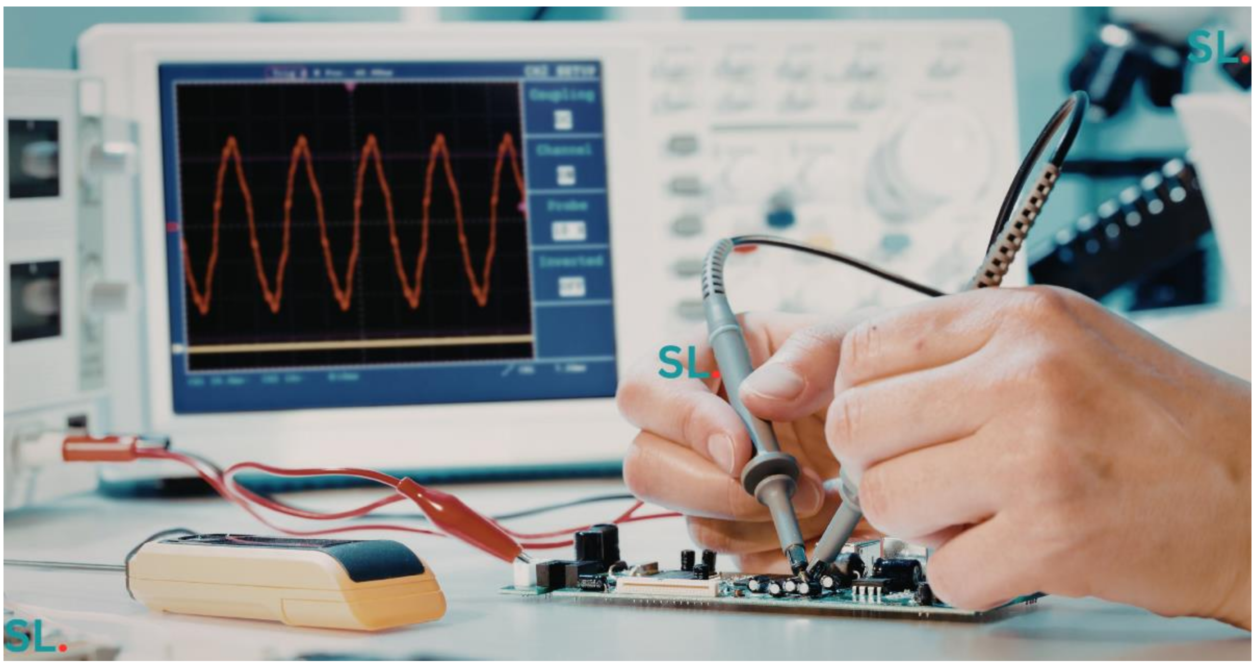
🔗 **Want to go deeper?**

Signal processing concepts are central to careers in wireless communications, power quality analysis, audio engineering, and control systems. I have come across mentees who skip portions of this knowledge area based on their preferences. It is about being strategic while leaving "no stone unturned." Check ShaiLearning for help via a 1-1 session.

Chapter 12: Knowledge Area 9 — Electronics

Questions on exam: 7–11 | A substantial section covering the devices that power modern technology.

Electronics is where semiconductor physics becomes engineering. The devices covered in this knowledge area — diodes, transistors, op-amps, and power conversion devices — are the building blocks of virtually every piece of electrical equipment in existence. Understanding how they work, how they are biased, and how they perform in circuits is fundamental to electrical engineering practice.



What NCEES Tests in Electronics

A. Models, Biasing, and Performance of Discrete Devices

This covers diodes, transistors (both bipolar junction transistors and MOSFETs), and thyristors. For each device, the exam tests your understanding of the device model (how it is represented mathematically and in circuit diagrams), how it is biased (how DC operating point is established), and how it performs (what its current-voltage relationship looks like and what determines its operating region). Diodes are the simplest two-terminal semiconductor device — understanding how they allow current in one direction and block it in the other is the entry point. Transistors add a control terminal, enabling amplification and switching behavior.

B. Amplifiers

Amplifiers increase the amplitude of signals. The exam tests single-stage amplifier configurations (particularly the common-emitter configuration for BJTs and the common-source configuration for MOSFETs), differential amplifiers (which amplify the difference between two signals and reject common-mode noise), and biasing techniques that establish stable operating points. Understanding gain — how much larger the output signal is compared to the input — in both voltage and current terms is central to this topic.

C. Operational Amplifiers — Ideal and Nonideal

The operational amplifier, or op-amp, is one of the most tested devices on the FE Electrical exam. In its ideal model — infinite input impedance, zero output impedance, infinite open-loop gain — the op-amp becomes remarkably simple to analyze using the virtual short concept. The standard configurations tested on the exam include the inverting amplifier, the non-inverting amplifier, the voltage follower (buffer), the summing amplifier, the integrator, and the differentiator. Understanding how negative feedback transforms the op-amp's behavior is the key conceptual insight for this section.

D. Instrumentation — Measurements, Data Acquisition, Transducers

This section covers how engineers measure physical quantities and convert them into electrical signals. Transducers convert one form of energy into another — thermocouples convert temperature into voltage, strain gauges convert mechanical deformation into resistance change, and photodiodes convert light into current. Data acquisition systems sample these signals and convert them to digital form for processing. Understanding measurement accuracy, resolution, and sampling in the context of real instruments is what the exam tests here.

E. Power Electronics — Rectifiers, Inverters, Converters

Power electronics is the application of electronic devices to convert and control electrical power. Rectifiers convert AC to DC — the first stage of most power supplies. Inverters do the opposite, converting DC to AC — the core of solar inverters and variable-frequency drives for motor control. Converters change DC voltage levels, either stepping up (boost converters), stepping down (buck converters), or inverting (buck-boost converters). These devices are at the heart of renewable energy systems, electric vehicles, and industrial motor control — all growing areas of electrical engineering practice.

From Shai

Electronics is a topic area where visual intuition matters as much as mathematical skill. Being able to picture what a circuit is doing — how current flows, where voltage drops occur, what the output waveform looks like — is just as important as being able to apply the formulas. Build both. The ShaiLearning mentorship program includes visual walkthroughs of all major electronics circuits. Visit shailearning.com to learn more.

Chapter 13: Knowledge Area 10 — Power Systems

Questions on exam: 8–12 | Critical for anyone pursuing the PE Power exam.

Power Systems is the domain closest to my own professional practice. I have spent my career working in power generation, transmission, and distribution. This knowledge area covers the fundamentals of how electrical power is generated, moved across distances, and delivered to consumers — and how the machines and equipment involved in that process work.

Even if your career focus is electronics or software, power systems concepts will appear on your FE exam. And if your intention is to pursue the PE Electrical & Computer — Power exam after your FE, mastering this section now is the most direct investment you can make.

What NCEES Tests in Power Systems

A. Power Theory — Power Factor, Single and Three Phase, Voltage Regulation

Power in AC systems is more complex than in DC systems. Real power (measured in watts) is the power that does actual work. Reactive power (measured in volt-amperes reactive, or VAR) is the power that oscillates between the source and reactive components without doing useful work. Apparent power (measured in volt-amperes) is the vector combination of real and reactive power.

Power factor is the ratio of real power to apparent power. A low power factor means the system is carrying current that is not doing useful work, which is inefficient and expensive.

Three-phase power systems are the standard for all large-scale power generation and distribution because they are more efficient and provide smoother power delivery than single-phase systems. The exam tests the relationships between line and phase voltages and currents in both Wye (Y) and Delta (Δ) configurations, and how total power is calculated in three-phase systems.

Voltage regulation describes how well a system maintains its output voltage as load conditions change. A well-designed power system has tight voltage regulation — the delivered voltage stays close to the rated value even as demand fluctuates.

B. Transmission and Distribution

This covers how power is moved from generators to consumers. Real and reactive power losses in transmission lines, efficiency of power delivery, voltage drop across transmission lines, and the use of Wye and Delta transformer connections to step voltage up for efficient long-distance transmission and back down for safe distribution are all testable here.

C. Transformers

Transformers are the workhorses of the power grid — they step voltage up and down and provide electrical isolation between circuits. The exam tests single-phase and three-phase transformer connections, the turns ratio and its relationship to voltage and current transformation, and the concept of reflected impedance (how an impedance on one side of a transformer appears from the other side). Understanding ideal transformer behavior is the starting point; real transformers introduce core losses and copper losses that the exam may also address.

D. Motors and Generators

Electric motors and generators are the devices that convert between electrical and mechanical energy. The FE exam covers three primary types: synchronous machines (whose speed is directly tied to the power system frequency, used in large generators and synchronous motors), induction machines (the most common industrial motor, whose rotor speed slightly lags the synchronous speed due to slip), and DC machines (which offer excellent speed control and are used in applications requiring variable speed). For each type, the exam tests the basic operating principles, the relationship between speed and power system frequency, and the performance characteristics.

From Shai

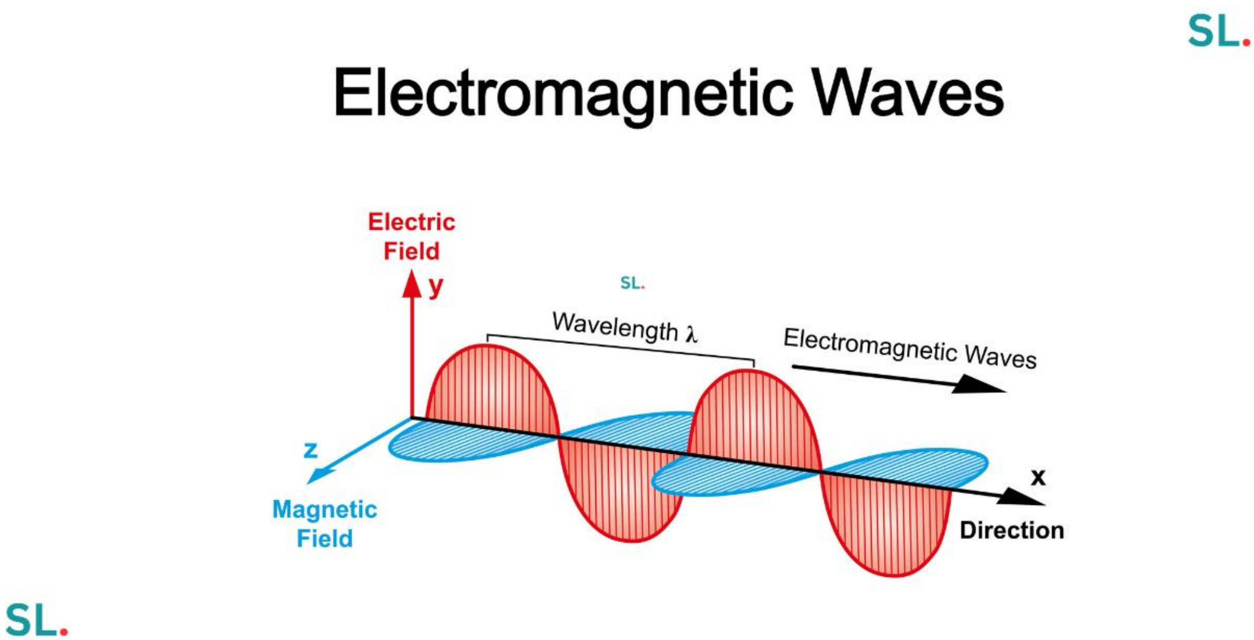
Power systems is where I live professionally. If you are interested in power generation, transmission, distribution, or renewable energy — this is your section. Do not let anyone tell you it is too niche for the FE exam. Eight to twelve questions is a significant chunk of your score. And if you are serious about the PE Power exam one day, the foundation you build here matters enormously. I mentor engineers through both FE and PE Power preparation at shailearning.com.

Chapter 14: Knowledge Area 11 — Electromagnetics

Questions on exam: 4–6 | Abstract but foundational — every electrical device traces back to these principles.

Electromagnetics is often the knowledge area that engineers find most conceptually challenging — not because the mathematics is unusually difficult, but because the phenomena are invisible and require strong physical intuition. Electric and magnetic fields cannot be seen directly, yet they govern the behavior of every electrical device ever built.

The FE exam tests electromagnetics at a level appropriate for an engineer in training — conceptual understanding and the ability to apply fundamental relationships to straightforward problems. Deep derivation is not required.



What NCEES Tests in Electromagnetics

A. Electrostatics and Magnetostatics

Electrostatics covers the behavior of electric fields produced by stationary electric charges. Key concepts include Coulomb's law (the force between point charges), electric field intensity (the force per unit charge at a point in space), electric flux and Gauss's law (a powerful tool for finding electric fields in symmetric configurations), electric potential (the voltage at a point in space), and capacitance (how much charge a structure can store per unit voltage).

Magnetostatics covers magnetic fields produced by steady (DC) currents. Key concepts include Ampere's law (the relationship between current and the magnetic field it produces), the Biot-Savart law (calculating the magnetic field produced by a current-carrying conductor), magnetic flux density, and inductance (how much magnetic flux links a circuit per unit current). Vector analysis is the mathematical language throughout — this is where your investment in the Mathematics knowledge area pays off.

B. Electrodynamics — Maxwell's Equations and Wave Propagation

Maxwell's four equations are the complete description of how electric and magnetic fields interact and propagate. At the FE exam level, you are expected to know what each equation represents physically — Gauss's law for electric fields, Gauss's law for magnetic fields (confirming no magnetic monopoles exist), Faraday's law of electromagnetic induction (changing magnetic fields create electric fields — the principle behind generators and transformers), and the Ampere-Maxwell law (current and changing electric fields create magnetic fields). Together, these equations predict that electromagnetic energy propagates as waves at the speed of light — the foundation of all wireless communication.

C. Transmission Lines at High Frequency

At high frequencies, the wires connecting circuit components can no longer be treated as ideal conductors with no effect on the circuit. Instead, they must be modeled as transmission lines with distributed inductance and capacitance per unit length. Key concepts include characteristic impedance (the impedance that a semi-infinite transmission line presents to a source), reflection coefficient (what fraction of a signal is reflected back when the line connects to a load that does not match its characteristic impedance), voltage standing wave ratio (VSWR, a measure of how much mismatch exists), and the condition for maximum power transfer (the load impedance must equal the characteristic impedance).

> **Pro Tip**
> Electromagnetics questions often include visual components — you may be asked to identify the direction of a field, interpret a field diagram, or reason about how a field changes with distance from a source. Study the concepts with diagrams, not just formulas.

Chapter 15: Knowledge Area 12 — Control Systems

Questions on exam: 6–9 | The discipline that keeps engineering systems stable and responsive.

Control systems engineering is about making systems behave the way you want them to — maintaining a desired output in the presence of disturbances, tracking a changing reference, and doing all of this without oscillating out of control. From the thermostat in your building to the autopilot in an aircraft to the voltage regulator in a power supply, control systems are everywhere.

What NCEES Tests in Control Systems

A. Block Diagrams — Feedforward and Feedback

Block diagrams are the graphical language of control systems. They represent how signals flow through a system — from the reference input, through the controller, through the plant (the physical system being controlled), and back through the feedback path. Understanding how to read and simplify block diagrams, and how to derive the closed-loop transfer function from an open-loop description, is the foundational skill for this knowledge area.

B. Bode Plots

A Bode plot is a graphical tool that displays a system's frequency response — how its gain and phase shift change with the frequency of the input signal. The gain plot shows the output-to-input amplitude ratio in decibels versus frequency on a logarithmic scale. The phase plot shows the phase shift between input and output. Bode plots are used to determine stability margins, design compensators, and specify filter performance. The exam tests your ability to read and interpret Bode plots and to identify key features such as gain crossover frequency and phase crossover frequency.

C. Closed-Loop Response, Open-Loop Response, and Stability

A control system is stable if its output remains bounded for any bounded input — if it does not grow without limit or oscillate with increasing amplitude. Stability analysis is one of the most fundamental tasks in control engineering. The exam tests stability using the Routh-Hurwitz criterion (an algebraic test applied to the characteristic polynomial of the closed-loop transfer function) and through the concepts of gain margin and phase margin derived from Bode plots.

D. Controller Performance — Steady-State Errors, Settling Time, Overshoot

Beyond stability, a control system must also perform well. Key performance metrics include steady-state error (how close the output gets to the desired value after all transients have died out), settling time (how long it takes the output to settle within an acceptable range of the final value), and percent overshoot (how much the output exceeds the final value before settling). Understanding how controller type and gain affect these metrics — and the fundamental trade-offs between speed of response and stability — is the core of controller design.

> 🔗 **Want to go deeper?**
> Control systems is a topic that connects deeply to power systems (voltage and frequency regulation) and electronics (feedback amplifier design). If you want to understand how these connections work in practice, visit shailearning.com for mentorship resources and to book a 1-on-1 session.

Chapter 16: Knowledge Area 13 — Communications

Questions on exam: 5–8 | The engineering of information transmission.

Communications engineering is the discipline concerned with transmitting information reliably and efficiently from one place to another. Every cell phone call, every internet data packet, every radio broadcast, and every satellite link is governed by the principles tested in this knowledge area.

What NCEES Tests in Communications

A. Basic Modulation and Demodulation Concepts — AM, FM, PCM

Modulation is the process of embedding an information signal onto a carrier wave for transmission. Amplitude Modulation (AM) encodes information in the amplitude variations of a carrier. Frequency Modulation (FM) encodes information in the frequency variations of a carrier — FM radio is more resistant to noise than AM because amplitude noise does not affect the frequency. Pulse Code Modulation (PCM) is the foundation of digital communications: the analog signal is sampled at regular intervals, each sample is quantized to a discrete level, and the quantized value is encoded as a binary number for transmission. PCM is the basis of digital telephony, CDs, and most modern digital audio.

B. Fourier Transforms and Fourier Series

The Fourier series decomposes any periodic signal into a sum of sinusoids at the fundamental frequency and its harmonics. The Fourier transform extends this concept to non-periodic signals, producing a continuous frequency spectrum. These tools are fundamental to all communications engineering because they reveal what frequencies a signal contains — which is essential for filter design, bandwidth allocation, and spectral analysis. The FE Reference Handbook contains the key Fourier transform pairs and properties.

C. Multiplexing — Time Division, Frequency Division, Code Division

Multiplexing is the technique of combining multiple signals for transmission over a single channel. Time Division Multiplexing (TDM) allocates different time slots to different signals — each user takes a turn. Frequency Division Multiplexing (FDM) allocates different frequency bands to different signals — each user has their own channel. Code Division Multiplexing (CDM), the basis of CDMA cellular technology, allows all users to transmit simultaneously over the same frequency band, separated by unique coding sequences.

D. Digital Communications

Digital communications encompasses the transmission of binary data — the 1s and 0s that represent all digital information. Key concepts include channel capacity (Shannon's theorem establishes the theoretical maximum information rate for a noisy channel), digital modulation techniques such as QAM (Quadrature Amplitude Modulation), BPSK, and QPSK, and the effect of noise on bit error rate. Understanding why digital communications is more robust than analog transmission is a conceptual insight the exam expects you to be able to explain and apply.

Chapter 17: Knowledge Area 14 — Computer Networks

Questions on exam: 4–6 | Increasingly critical as engineering systems become networked.

The power grid is becoming a smart grid. Industrial equipment is networked through industrial IoT. Building management systems communicate over TCP/IP. Understanding computer networking is no longer optional for electrical engineers — it is a core competency, and the FE exam reflects that.

What NCEES Tests in Computer Networks

A. Routing and Switching

Routing is the process of determining the path that data packets take through a network from source to destination. Routers make forwarding decisions based on IP addresses and routing tables. Switching is the process of forwarding data frames within a local network based on MAC addresses. Switches operate at the data link layer; routers operate at the network layer. Understanding the distinction between routing and switching — and when each is used — is the foundational concept here.

B. Network Topologies — Mesh, Ring, Star

Network topology describes the physical or logical arrangement of nodes in a network. A star topology connects all nodes to a central hub or switch — the most common LAN arrangement. A ring topology connects nodes in a closed loop. A mesh topology provides multiple paths between nodes, offering redundancy. Each topology has characteristic reliability, cost, and performance trade-offs that the exam may test.

C. Network Types — LAN, WAN, Internet

A Local Area Network (LAN) connects devices within a limited geographic area — a building, a campus, or an industrial facility. A Wide Area Network (WAN) spans large geographic areas, connecting LANs together — the internet is the most extensive WAN. Understanding the scale, technology, and purpose of different network types provides context for the more detailed protocol and security topics.

D. Network Models — OSI and TCP/IP

The OSI model organizes network functions into seven layers: Physical, Data Link, Network, Transport, Session, Presentation, and Application. The TCP/IP model is a practical four-layer implementation: Network Access, Internet, Transport, and Application. Knowing which protocols and functions belong to which layer — and why the layered architecture is useful — is what the exam tests. HTTP, TCP, IP, Ethernet, and WiFi are all examples of protocols that map to specific OSI/TCP-IP layers.

E. Network Intrusion Detection and Prevention

This covers the technologies used to detect and prevent unauthorized access to networked systems: firewalls (which filter traffic based on defined rules), intrusion detection systems (IDS, which monitor for suspicious activity), and endpoint detection systems (which monitor individual devices for compromise).

F. Network Security

Security topics include port scanning (the technique used to discover which services are exposed on a host), network vulnerability testing (assessing a network for exploitable weaknesses), web vulnerability testing, penetration testing (authorized simulated attacks to find vulnerabilities), and the security triad — Confidentiality, Integrity, and Availability (CIA). These concepts are increasingly important as industrial control systems, power grids, and infrastructure become networked targets.

Chapter 18: Knowledge Area 15 — Digital Systems

Questions on exam: 8–12 | One of the highest-weighted areas — do not underestimate it.

Digital systems is the knowledge area that covers how digital logic works — from the binary number representation of information, all the way up to the design of complete digital circuits. This section, alongside Circuit Analysis and Mathematics, is one of the highest question-count areas on the FE Electrical & Computer exam. Engineers who came from a more analog-focused program sometimes pay little attention in this area. Do not make that mistake.

What NCEES Tests in Digital Systems

A. Number Systems

Digital systems represent all information in binary — base 2. The exam tests your ability to convert between binary, decimal, hexadecimal, and octal number systems, to perform binary arithmetic (addition, subtraction, multiplication, and division), and to understand two's complement representation (the standard way of representing negative numbers in binary digital systems).

B. Boolean Logic

Boolean algebra is the mathematics of logic. It operates on variables that can only have two values: 0 (false) or 1 (true). Boolean operations — AND, OR, NOT, NAND, NOR, XOR — are the building blocks of all digital logic. Boolean algebra has its own laws and theorems that allow simplification of logic expressions, and the exam tests your ability to apply them.

C. Logic Gates and Circuits

Logic gates are the physical implementation of Boolean operations in electronic circuits. Each gate type has a characteristic symbol, truth table, and behavior. Digital circuits are built by connecting logic gates to implement more complex functions. Reading circuit diagrams, writing truth tables, and determining the output of a logic circuit from a given input are all skills tested on the FE exam.

D. Logic Minimization — SOP, POS, Karnaugh Maps

Logic minimization is the process of finding the simplest Boolean expression that implements a desired truth table. Sum of Products (SOP) and Product of Sums (POS) are the two standard forms. Karnaugh maps (K-maps) are a visual tool for systematically minimizing logic expressions by grouping adjacent cells in the map that represent minterms or maxterms. Minimizing logic reduces the number of gates required, which reduces cost, power consumption, and propagation delay.

E. Flip-Flops and Counters

Flip-flops are bistable digital devices — they can store a single binary bit by remaining stable in either of two states. They are the fundamental building block of digital memory and sequential logic. SR, D, JK, and T flip-flops each have distinct behavior and triggering characteristics. Counters are sequences of flip-flops connected to count events — they are used in timers, frequency dividers, and digital clocks.

F. Programmable Logic Devices and Gate Arrays

Programmable Logic Devices (PLDs) and Field Programmable Gate Arrays (FPGAs) are integrated circuits whose logic can be configured after manufacture. They allow engineers to implement custom digital logic without designing a custom chip. Understanding the basic architecture and application of these devices is what the exam tests — not how to program them in detail.

G. State Machine Design

A finite state machine (FSM) is a digital system that has a finite number of possible states and transitions between them based on inputs. State machines are used to model and implement sequential control logic — traffic light controllers, vending machines, serial communication protocols, and many other digital systems are naturally described as state machines. The exam tests your ability to construct state diagrams, state tables, and to design the logic that implements them.

H. Timing — Diagrams, Asynchronous Inputs, Race Conditions and Hazards

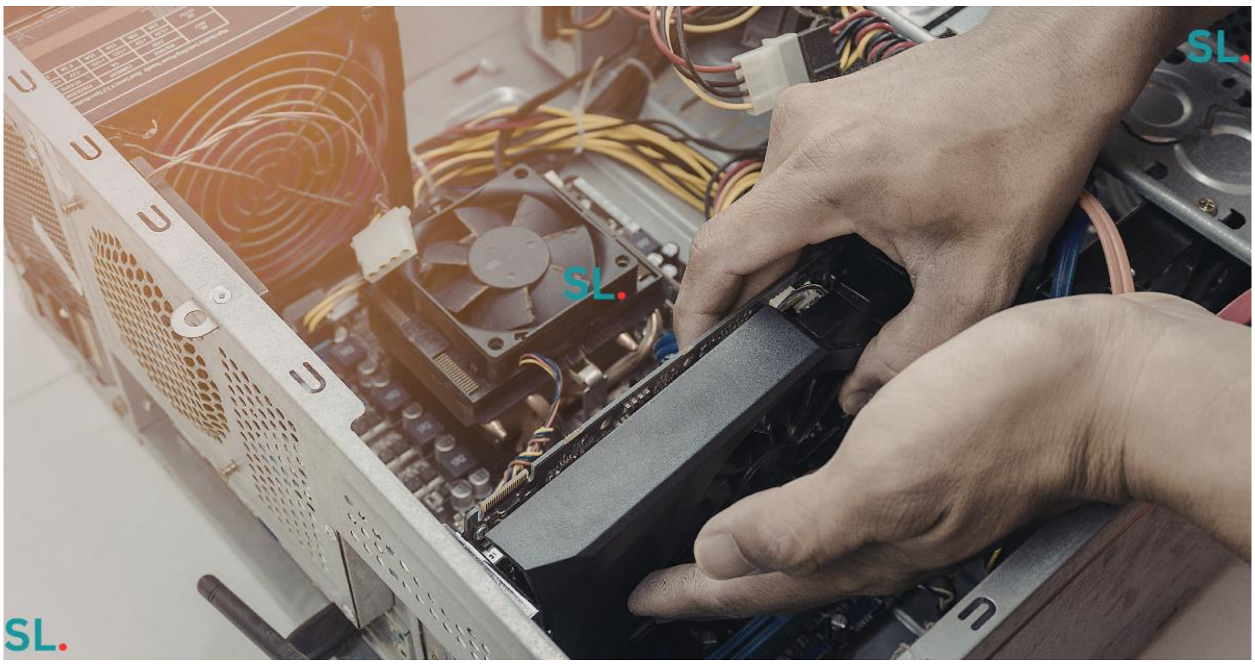
Digital circuits do not respond instantaneously — every logic gate introduces a propagation delay. Timing diagrams show how signals change over time and how delays affect circuit behavior. Asynchronous inputs (signals that are not synchronized to the system clock) can cause metastability and unreliable operation. Race conditions occur when two signals compete to determine the output, and the result depends on which arrives first. Hazards are unwanted transient outputs caused by different propagation delays through different circuit paths. Understanding these phenomena is important for reliable digital design.

> **From Shai**
>
> Digital Systems had more questions on my FE exam than I expected. I had focused so heavily on circuits and power that I did not give it the weight it deserved. Eight to twelve questions is a lot when your margin for error is as thin as it is on this exam. Give digital systems the study time it deserves.

Chapter 19: Knowledge Area 16 — Computer Systems

Questions on exam: 5–8 | The hardware foundation of modern computing.

Computer Systems covers how the hardware components of computing systems work — microprocessors, memory, and the interfaces that connect them. As embedded systems, microcontrollers, and digital signal processors become ubiquitous in electrical engineering applications, this knowledge area is increasingly relevant to practicing engineers across all specializations.



What NCEES Tests in Computer Systems

A. Microprocessors

A microprocessor is a programmable digital device that executes a stored sequence of instructions. Understanding microprocessor architecture — the central processing unit (CPU), instruction sets, addressing modes, the fetch-decode-execute cycle, and how instructions are pipelined for efficiency — is the core of this subtopic. The exam does not test the specific architecture of any particular processor brand; it tests the general principles that apply across all microprocessor designs.

B. Memory Technology and Systems

Memory stores the data and instructions that a processor works with. The exam covers the different types of memory and their characteristics: RAM (Random Access Memory — volatile, fast, used for active program data), ROM (Read Only Memory — nonvolatile, used for firmware and boot code), cache memory (very fast, small capacity, holds recently accessed data to reduce main memory access time), and flash memory (nonvolatile, electrically erasable, used in SSDs and embedded systems). Understanding the memory hierarchy — how cache, main memory, and secondary storage are organized to balance speed and capacity — is an important conceptual topic.

C. Interfacing

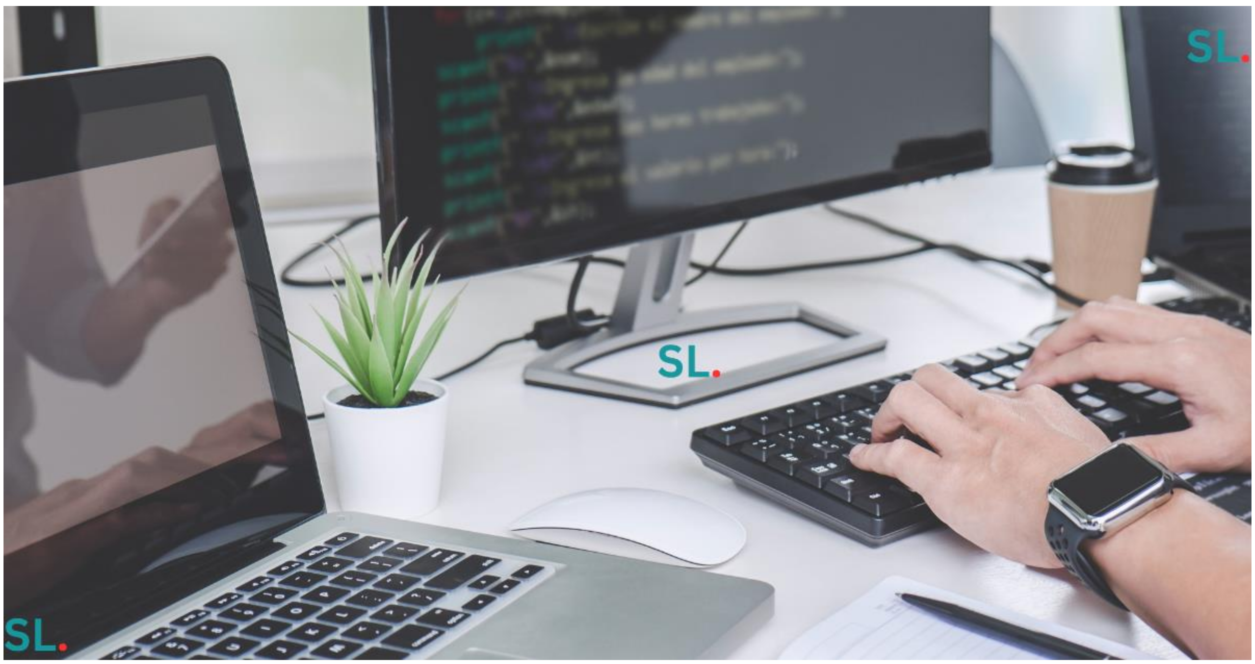
Interfacing covers how a microprocessor communicates with the outside world — with memory, with peripherals (keyboards, displays, sensors, actuators), and with other processors. Key concepts include input/output (I/O) techniques (programmed I/O, interrupt-driven I/O, and DMA — Direct Memory Access), serial communication protocols (UART, SPI, I2C), and parallel bus interfaces. Understanding the trade-offs between different interfacing approaches — speed, hardware complexity, software overhead — is what the exam tests.

> **Strategic Tip**
> Computer Systems questions on the FE exam are often more conceptual than computational — they test whether you understand how the pieces of a computer system fit together and why they are designed the way they are. Approach this section with the same conceptual mindset as the Electromagnetics section, and you will do well.

Chapter 20: Knowledge Area 17 — Software Engineering

Questions on exam: 4–6 | The smallest section, but no less important — these are points on the table.

Software engineering is the application of systematic, disciplined, and quantifiable approaches to the development, operation, and maintenance of software. In the context of the FE Electrical & Computer exam, this knowledge area focuses on the fundamental concepts of algorithms, data structures, and software implementation that every engineer — regardless of specialization — should understand.



What NCEES Tests in Software Engineering

A. Algorithms — Sorting, Searching, Complexity, Big-O Notation

An algorithm is a step-by-step procedure for solving a problem. The exam tests your understanding of fundamental algorithms — particularly sorting algorithms (such as bubble sort, insertion sort, merge sort, and quicksort) and searching algorithms (such as linear search and binary search). Equally important is algorithm complexity — how the computation time and memory requirements of an algorithm scale as the size of the input grows. Big-O notation is the standard way of expressing this scaling behavior. Understanding that a binary search runs in

O(log n) time while a linear search runs in O(n) time, and knowing what that means for practical performance, is the type of conceptual knowledge the exam tests.

B. Data Structures — Lists, Trees, Vectors, Structures, Arrays

A data structure is a way of organizing data so that it can be accessed and manipulated efficiently. Arrays store elements in a contiguous block of memory, allowing direct access by index. Linked lists store elements at arbitrary memory locations, connected by pointers — efficient for insertion and deletion, but slow for random access. Trees organize data hierarchically — binary search trees, in particular, allow efficient search, insertion, and deletion. Vectors are dynamic arrays that resize automatically. Understanding which data structure is appropriate for a given problem, and what the performance trade-offs are, is what this section tests.

C. Software Implementation — Iteration, Conditionals, Recursion, Control Flow, Scripting, Testing

This covers the fundamental constructs of programming: iteration (loops — for, while, do-while), conditionals (if-else statements, switch cases), and recursion (functions that call themselves to solve a problem by breaking it into smaller instances of the same problem). Control flow describes how program execution moves through these constructs. Scripting refers to the use of interpreted languages for automation and quick development. Software testing covers the strategies for verifying that a program behaves correctly — unit testing, integration testing, and regression testing are the primary categories.

> 📌 **Note**
> Software Engineering questions are among the most accessible on the FE exam for candidates from a computer engineering background. For candidates with a pure electrical engineering focus, invest one focused study session in algorithms and data structures — these questions are very learnable with the right preparation. Ill-preparation is not an option.

Chapter 21: Exam Strategy — How to Study and What to Prioritize

In November 2021, I walked into the FE exam room. I have failed once and passed once. I have mentored engineers through both outcomes. The experience of both outcomes has shaped my understanding and the need to help you. What I am going to share with you in this chapter is not theory — it is what actually works.

Know the Weight of Each Section

The single most important strategic decision you can make is allocating your study time proportionally to the number of questions each knowledge area carries. Here is what the CBT specifications tell us:

Knowledge Area	Questions	Study Priority
1. Mathematics	11–17	Very High
6. Circuit Analysis (DC & AC)	11–17	Very High
10. Power Systems	8–12	High
15. Digital Systems	8–12	High
9. Electronics	7–11	High
12. Control Systems	6–9	High
4. Engineering Economics	5–8	Medium
7. Linear Systems	5–8	Medium
8. Signal Processing	5–8	Medium
11. Electromagnetics	4–6	Medium
13. Communications	5–8	Medium
16. Computer Systems	5–8	Medium
2. Probability & Statistics	4–6	Medium
3. Ethics & Professional Practice	4–6	Medium
5. Electrical Materials	4–6	Medium

14. Computer Networks	4–6	Medium
17. Software Engineering	4–6	Medium

A Practical 12-Week Study Framework

Phase	Focus
Weeks 1–2: Diagnostic	Take a full practice exam under real conditions. Download the FE Reference Handbook. Identify your three weakest areas from the diagnostic. Build your study calendar from there.
Weeks 3–5: Foundation	Mathematics, Circuit Analysis (DC), Complex Numbers. These underpin everything else. Work through the FE Reference Handbook sections for each topic.
Weeks 6–8: Core Technical	Circuit Analysis (AC), Electronics, Power Systems, Digital Systems. These four areas alone represent 35–52 questions on your exam.
Weeks 9–10: Breadth	Linear Systems, Signal Processing, Control Systems, Electromagnetics, Communications. Work through each systematically.
Week 11: Remaining Areas	Computer Networks, Computer Systems, Software Engineering, Ethics, Engineering Economics, Probability. Many of these are highly learnable in a short, focused effort.
Week 12: Simulation	Two full 110-question timed practice sessions in exam conditions. Review every wrong answer. Rest two days before exam day.

Using the FE Reference Handbook as a Study Tool

Most candidates use the FE Reference Handbook only as an exam tool. The candidates who pass most consistently use it as a study tool from day one. Every practice problem you solve should be solved using only what is available in the handbook — this trains your muscle memory for navigating it efficiently during the actual exam.

Exam Day Mindset

- Arrive 30 minutes early. The check-in process takes time and you do not want to start your exam feeling rushed
- Mark difficult questions and move on — do not let a hard problem eat 10 minutes of your time
- Use the optional break between the two sessions to reset your focus
- The handbook is your ally — use it actively for every problem where it is relevant

- If you are unsure of an answer, eliminate clearly wrong choices and make an informed guess — there is no penalty for wrong answers

From Shai

My advice for exam day: trust your preparation. You will encounter questions that feel unfamiliar. Every candidate does. The exam, like many exams we have taken before, whether in college or sometimes in our education, is designed that way. Your job is not to know everything — it is to maximize the points available to you from what you do know, and to make smart strategic decisions on the rest. That is what preparation builds. If you want to build that preparation with structured support, do not hesitate to reach out to me at shailearning.com.

Chapter 22: The International Candidate's Pathway

This chapter is personal. Not as a rhetorical device — genuinely, personally significant. Because I was an international candidate. I came from Ghana. I went through every step I am about to describe. Some of it was confusing. Some of it was frustrating. And all of it was worth it in the long run.

If you are an engineer who trained outside the United States and you want to pursue U.S. licensure — whether you plan to move to the U.S. or obtain the credential while living abroad — this chapter is your roadmap.

From Shai

To every engineer reading this from outside the United States: the process may look complicated. It is not impossible. I am proof of that. And I built ShaiLearning.com specifically so that you do not have to figure it out the way I did — piece by piece, in the dark. Book a 1-on-1 call with me at shailearning.com, and we will map out your specific pathway together.

The International Candidate Pathway — Step by Step

Step	What to Do
1 — Check ABET Accreditation	Go to abet.org and search for your engineering program. If your program is ABET-accredited, your path is more straightforward. If it is not — which is common for programs outside the U.S. — proceed to Step 2.
2 — NCEES Credentials Evaluation	Apply at ncees.org. Request your school to submit your transcripts, degree certificates, and course syllabi. NCEES evaluates your academic background against ABET standards and reports its findings to your chosen U.S. state board. The current fee is $400 (confirm at ncees.org).
3 — Choose Your State Board	You must apply to a U.S. state board for licensure — there is no single national license. Some states are more accessible to international candidates. Texas, Florida, and Oregon are commonly recommended starting points. Research each board's specific requirements for international applicants.
4 — Create Your MyNCEES Account	Register at ncees.org. Your NCEES Record becomes your portable credential file — it holds your exam scores, credential evaluations, and experience records, all of which are transferable across states.
5 — Register and Take the FE Exam	Register through MyNCEES and schedule at your nearest Pearson VUE center. If you are in an NCEES-agreement country (Canada/Alberta, Saudi Arabia, UAE, Egypt, Turkey, Japan), you can test locally. For other countries,

	Pearson VUE has centers in over 180 nations — check home.pearsonvue.com/ncees for availability near you.
6 — Gain Qualifying Experience	After passing the FE, you typically need 4 years of progressive engineering experience under a licensed PE. For international candidates, experience gained outside the U.S. may count depending on your state board. You need to confirm this with your state board, as some states do not accept work experience outside the U.S. as "professional engineering experience." However, document everything carefully.
7 — Apply for the PE Exam	Apply to your state board — not NCEES directly — at least 4 months before your target exam date. Once approved, register with NCEES and pay the exam fee.
8 — Achieve PE Licensure	Pass the PE exam. Your state board issues your license. Maintain your NCEES Record for reciprocity to other states and eventual eligibility for the NCEES International Registry.

Washington Accord — A Helpful Bridge

If your degree is from a country whose accreditation system is a signatory to the Washington Accord, the NCEES credentials evaluation typically proceeds more smoothly. Washington Accord members include Australia, Canada, China, Hong Kong, India, Ireland, Japan, South Korea, New Zealand, Pakistan, Russia, Singapore, South Africa, Sri Lanka, Taiwan, Turkey, Costa Rica, Peru, Malaysia, and the United Kingdom. This mutual recognition of accreditation standards does not replace the evaluation, but it simplifies it.

UK Engineers — The MRA Fast Track

If you hold both Chartered Engineer (CEng) status and IntPE status through the Engineering Council UK (ECUK), you may be eligible to apply for a U.S. PE license via the Mutual Recognition Agreement between NCEES and ECUK — with the **FE and PE exams potentially waived**. The participating states include Alaska, Delaware, Georgia, Idaho, Illinois, Maine, Maryland, and others as shown in the Figure below. Contact ECUK at ecuk.org.uk to begin this process.


SL.
Alaska
Delaware
Georgia
Idaho
Nevada
SL.
Illinois PE
Illinois SE
Maine
Wyoming
North Carolina
Oklahoma
Utah
Maryland
Nebraska
Texas
ShaiLearning.com
SL.
SL.

Chapter 23: After the FE — Your EIT Designation & Path to PE

Passing the FE exam is a milestone — a real one. Take a moment to recognize it. And then get to work on what comes next, because the FE is the beginning, not the end.

What to Do Immediately After Passing

1. Check your MyNCEES account — your pass notification will be there within 7–10 business days after your exam.
2. Download your official pass notification letter for your records.
3. Contact your state licensing board — in some states (like New Jersey), you must submit a separate application to receive your EIT certificate. This is not automatic in every state.
4. Update your resume and LinkedIn profile with your EIT or EI designation and the date you passed. This is not mandatory, but it helps build your personal profile.
5. Begin documenting your engineering experience immediately — do not wait four years to reconstruct what you did and when.

Building Your Experience Record — The Most Underrated Step

Most EITs underestimate how important their experience documentation is. State boards do not just want a job title and an employer name. They want to know what engineering work you actually did, what decisions you made, what systems you designed or analyzed, and who supervised you. The PE application will ask for this in detail.

Start keeping a contemporaneous experience log today. For each project, record: the project description, your specific engineering role, the decisions you made, the name and PE license number of your supervising engineer, and the dates of your involvement. A well-maintained experience log makes your PE application straightforward. A poorly maintained one makes it a stressful reconstruction project.

Bear in mind that the style of documenting your professional experience is somewhat different from that of a typical resume/CV.

Choosing Your PE Discipline

For Electrical & Computer engineers, there are currently three PE exam disciplines available:

PE Discipline	Best For
PE Electrical & Computer — Power	Power generation, transmission, distribution, renewable energy, and utility work. New specifications effective October 2025.
PE Electrical & Computer — Electronics, Controls & Communications	Signal processing, control systems, RF engineering, embedded systems, communications.
PE Electrical & Computer — Computer Engineering	Computer architecture, systems design, and software-intensive engineering systems. Single-day exam.

The Timeline at a Glance

Milestone	Typical Timeframe
Pass FE exam / Receive EIT designation	Year 0
Begin accumulating qualifying experience	Years 0–4
Submit your PE application to the state board	Plan 4 months before the target exam (Year 4)
Board approval received	2–6 weeks after complete application
Register with NCEES, pay PE fee	Immediately after board approval
Schedule PE exam at Pearson VUE	Immediately after NCEES registration
Take PE exam	Year 4–5 (may differ based on your degree or sometimes experience)
Apply and receive PE license from the state board	Weeks after passing the PE exam. It depends on the State Board. Always check the application timeline with your state Board.

🔗 **Want to go deeper?**
The path from EIT to PE is manageable with the right guidance and accountability. ShaiLearning.com offers mentorship for both the FE exam journey and the full FE-to-PE track. Visit shailearning.com to learn about current program openings, and book a 1-on-1 call to map out your specific timeline.

Chapter 24: References & Resources

Every data point, official policy detail, and procedural requirement in this guide traces back to official NCEES sources or peer-reviewed reference materials. The resources below were verified as early as 2025 and may change at any time. The engineering licensure landscape updates regularly. As such, always verify critical details at the official NCEES website before making decisions.

Official NCEES Sources

- NCEES FE Exam Main Page: ncees.org/exams/fe-exam/
- FE Electrical & Computer CBT Exam Specifications (PDF): ncees.org/wp-content/uploads/FE-Electrical-and-Computer-CBT-specs.pdf
- NCEES Examinee Guide (November 2025): ncees.org/exams/examinee-guide/
- NCEES FE Reference Handbook (free PDF): available after account creation at account.ncees.org
- NCEES International Professionals: ncees.org/licensure/international-professionals/
- NCEES Licensing Boards Directory: ncees.org/licensing-boards/
- NCEES Squared Annual Report 2024: ncees.org/wp-content/uploads/2025/02/Squared-2024_pages.pdf
- NCEES Exam Fees (effective January 1, 2024): ncees.org/exams/

ShaiLearning.com Resources

- FE Electrical Guide and Mentorship Program: shailearning.com
- Book a 1-on-1 mentorship call: shailearning.com/book
- FE Exam eligibility checker and resources: shailearning.com/fe-electrical-guide
- Waitlist for FE and PE mentorship cohorts: shailearning.com/waitlist

Additional Reference Resources

- ABET Accredited Program Search: abet.org
- International Engineering Alliance — Washington Accord: ieagreements.org/accords/washington/
- Engineering Council UK — CEng and IntPE: ecuk.org.uk
- NSPE Code of Ethics for Engineers: nspe.org/resources/ethics/code-ethics
- IEEE Code of Ethics: ieee.org/about/corporate/governance/p7-8.html

Ready to go further? Your PE license is waiting if you take action now.

Visit shailearning.com to join the mentorship program, access additional study resources, and book a 1-on-1 call with a Licensed Professional Engineer who has lived this journey.