PE

electrical and computer: power
practice exam

For the computer-based exam
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About NCEES
NCEES is a nonprofit organization made up of the U.S. engineering and surveying licensing boards in all 50 states, the U.S. territories, and the District of Columbia. We develop and score the exams used for engineering and surveying licensure in the United States. NCEES also promotes professional mobility through its services for licensees and its member boards.

Engineering licensure in the United States is regulated by licensing boards in each state and territory. These boards set and maintain the standards that protect the public they serve. As a result, licensing requirements and procedures vary by jurisdiction, so stay in touch with your board (ncees.org/licensing-boards).

Exam Format
The PE Electrical and Computer: Power Exam is computer-based. It contains 80 questions and is administered year-round via computer at approved Pearson VUE test centers. A 9-hour appointment time includes a tutorial, the exam, and a break. You’ll have 8 hours to complete the actual exam.

In addition to traditional multiple-choice questions with one correct answer, the PE Power exam uses common alternative item types such as
• Multiple correct options—allows multiple choices to be correct
• Point and click—requires examinees to click on part of a graphic to answer
• Drag and drop—requires examinees to click on and drag items to match, sort, rank, or label
• Fill in the blank—provides a space for examinees to enter a response to the question

To familiarize yourself with the format, style, and navigation of a computer-based exam, view the demo on ncees.org/ExamPrep.

Examinee Guide
The NCEES Examinee Guide is the official guide to policies and procedures for all NCEES exams. During exam registration and again on exam day, examinees must agree to abide by the conditions in the Examinee Guide, which includes the CBT Examinee Rules and Agreement. You can download the Examinee Guide at ncees.org/exams. It is your responsibility to make sure you have the current version.

Scoring and reporting
Results for computer-based exams are typically available 7–10 days after you take the exam. You will receive an email notification from NCEES with instructions to view your results in your MyNCEES account. All results are reported as pass or fail.

Updates on exam content and procedures
Visit us at ncees.org/exams for updates on everything exam-related, including specifications, exam-day policies, scoring, and corrections to published exam preparation materials. This is also where you will register for the exam and find additional steps you should follow in your state to be approved for the exam.
The exam topics have not changed since April 2018 when they were originally published.

The PE Power exam is computer-based. It is closed book with an electronic reference. Codes and standards applicable to the PE Power exam are shown on ncees.org.

Examinees have 9 hours to complete the exam, which contains 80 questions. The 9-hour time includes a tutorial and an optional scheduled break. Examinees work all questions.

The exam uses both the International System of units (SI) and the US Customary System (USCS).

The exam is developed with questions that will require a variety of approaches and methodologies, including design, analysis, and application. Some questions may require knowledge of engineering economics.

The knowledge areas specified as examples of kinds of knowledge are not exclusive or exhaustive categories.

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      7. Single-line diagrams  
   B. Devices and Power Electronic Circuits  
      1. Battery characteristics and ratings  
      2. Power supplies and converters  
      3. Relays, switches, and ladder logic  
      4. Variable-speed drives  

3. **Rotating Machines and Electric Power Devices**  
   A. Induction and Synchronous Machines  
      1. Generator/motor applications  
      2. Equivalent circuits and characteristics  
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4. **Transmission and Distribution (High, Medium, and Low Voltage)**  
   A. Power System Analysis  
      1. Voltage drop  
      2. Voltage regulation  
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      6. Transformer connections  
      7. Transmission line models  
      8. Power flow  
      9. Power system stability  
   B. Protection  
      1. Overcurrent protection  
      2. Protective relaying (e.g., differential, distance, undervoltage, pilot)  
      3. Protective devices (e.g., fuses, breakers, reclosers)  
      4. Coordination
12. When using the method of symmetrical components, which of the following statements are most nearly correct?

Select all that apply.

- [ ] A. The three positive-sequence voltage phasors are equal in magnitude and displaced by 120°.
- [ ] B. The three negative-sequence voltage phasors are equal in magnitude and displaced by 120°.
- [ ] C. The three zero-sequence voltage phasors are equal in magnitude and displaced by 120°.
- [ ] D. The set of positive-sequence voltage phasors and set of negative-sequence voltage phasors have opposite phase rotation.
- [ ] E. The magnitude of the Phase A positive-sequence voltage phasor is equal to the magnitude of the Phase A negative-sequence voltage phasor.
31. A 3-phase capacitor rated at 240 V and 110 kvar has been proposed for correcting the power factor of a 3-phase induction motor operating at 208 V. The reactive power (kvar) that will be provided by the capacitor is most nearly:

- A. 82.6
- B. 95.3
- C. 110
- D. 127

32. Consider the 60-kV transmission system below. Transmission line impedances are:

\[
Z_1 = 16.75\angle 71^\circ \Omega \\
Z_2 = 13.4\angle 71^\circ \Omega
\]

With a system impedance of 13.25\angle 81^\circ \Omega, the 3-phase fault current (amperes) at Station C is most nearly:

- A. 2,590
- B. 1,495
- C. 1,285
- D. 800

33. According to the 2017 National Electrical Code® (NEC®), the maximum resistance to ground (\(\Omega\)) of a single grounding electrode without the requirement to add an additional grounding electrode is ________________.

Enter your response in the blank.
42. A 3-phase, 460-V, 25-hp induction motor draws 34 A at 0.75 lagging power factor from a 480-V source. The reactive power (kvar) required to correct the power factor to 0.90 lagging is most nearly:

- A. –2.8
- B. –4.9
- C. –8.4
- D. –14.6

43. Conduit fittings are to be used in an atmosphere containing sufficient concentrations of coal dust to present an explosion hazard under normal conditions. Select the Class, Division, and Material Group location designations for which the fittings must be marked for suitability according to the 2017 edition of the *National Electrical Code®* (NEC®).
74. The electrical power-angle curve ($P_e$) for a synchronous generator is shown in the figure. A 3-phase fault at the terminals of the generator causes the rotor angle to accelerate from its initial value, $\delta_0$. The fault is cleared when the rotor angle reaches $\delta_1$. Select the area that is directly proportional to the kinetic energy added to the rotor during the fault.
10. \[ I_c = \frac{500 \text{kVA}}{13.2 \text{kV}} = 37.9 \text{ A} \]

THE CORRECT ANSWER IS: (C)

11. Since the distribution system is balanced,
\[
V_{an} = \frac{12.5 \times 10^3}{\sqrt{3}} \angle -30^\circ + 70 \angle -20^\circ (5 + j10)
\]
\[
= 7.22 \times 10^3 \angle -30^\circ + 782.6 \angle 43.4^\circ
\]
\[
= (6.82 - j3.07) \times 10^3
\]
\[
= 7.48 \times 10^3 \angle -24.2^\circ
\]
\[
|V_{ab}| = 7.48 \times 10^3 \sqrt{3} = 12.95 \text{kV}
\]

THE CORRECT ANSWER IS: (C)

12. Options (A) and (B) are correct, by definition, from the transformation matrices shown in the Symmetrical Components section of the NCEES PE Electrical and Computer: Power Reference Handbook. Option (C) is incorrect since the zero-sequence voltage phasors are in phase (i.e., 0° displacement). Option (D) is correct, again by definition from the transformation matrices shown in the Symmetrical Components section of the Power Reference Handbook. Option (E) can be correct in certain specific instances but is not always correct. For example, in a balanced 3-phase system the magnitudes of the positive-sequence voltage set are finite, but the magnitudes of the negative sequence voltage set are zero.

THE CORRECT ANSWER IS: (A, B, D)
30. Since, after addition of the capacitor, the motor current will be more than the current seen by the overload relays, the relay trip settings should be reduced (NEC® Article 460.9). Option (B).

The current at the motor will not change since the capacitor will reduce current only between itself and the source. Eliminate (A).

A separate disconnect switch is not required when the capacitor is connected on the load side of a motor controller [NEC® Article 460.8 (c) exception]. Eliminate (C).

The installation of a capacitor does not change the required motor feed conductor size (NEC® Article 460.9). Eliminate (D).

THE CORRECT ANSWER IS: (B)

31. The vars vary as the square of the applied voltage.

\[ k\text{var} = \left(\frac{208}{240}\right)^2 (110) = 82.6 \]

THE CORRECT ANSWER IS: (A)

32. \[ I_{\text{Fault}} = \frac{60,000 / \sqrt{3}}{16.75 \angle 71^\circ + 13.4 \angle 71^\circ + 13.25 \angle 81^\circ} = 800 \text{ A} \]

THE CORRECT ANSWER IS: (D)

33. Refer to NEC® Article 250.53 (A)(2).

THE CORRECT ANSWER IS: 25

34. The grounding resistor at the neutral of the transformer will limit ground-fault current. Option (A).

For balanced loads, the potential difference between N and EG is 0. Eliminate (B).

The interrupting rating of M is sized for 3-phase faults. Eliminate (C).

THE CORRECT ANSWER IS: (A)
41. \[ V_{sec} = I_{line} \left( \frac{0.78 + j0.052}{1,000 \text{ ft}} \right) (200 \text{ ft}) + V_{load} + I_{line} \left( \frac{0.78 + j0.052}{1,000 \text{ ft}} \right) (200 \text{ ft}) \]

\[ = 240 \angle 0^\circ + (2)(30 \angle 0^\circ) \left( \frac{1}{5} \right) (0.78 + j0.052) \]

\[ = 249.4 \angle 0.143^\circ \text{ V} \]

\[ |V_{sec}| = 249.4 \text{ V} \]

**THE CORRECT ANSWER IS: (B)**

42. \[ S_{motor} = \sqrt{3}V_I I_I \cos^{-1} (pf) = \sqrt{3}(480)(34) \cos^{-1} (0.75) = 28.3 \angle 41.4^\circ \text{ kVA} \]

\[ Q_{\text{new}} = P \left[ \tan \left( \cos^{-1} \theta \right) \right] \]

\[ = 21.2 \left[ \tan \left( \cos^{-1} 0.9 \right) \right] = 10.3 \]

\[ Q_{\text{old}} = [\sin (\cos^{-1} 0.75)][\sqrt{3}(480)(34)] = 18.7 \]

\[ Q_{\text{new}} = Q_{\text{old}} + Q_{\text{add}} \]

\[ Q_{\text{add}} = Q_{\text{new}} - Q_{\text{old}} = 10.3 - 18.7 \]

\[ = -8.4 \text{ kvar} \]

**THE CORRECT ANSWER IS: (C)**

43. Per *NEC®* Article 500.8(C), the equipment marking must include (1) Class, (2) Division, and (3) Material Group.

- Since coal produces combustible dust, it is a Class II environment [*NEC®* Article 500.5(C)].
- Since the coal dust exists under normal conditions, it is a Division 1 environment [*NEC®* Article 500.5(C)(1)].
- Coal is a combustible carbonaceous dust in Material Group F [*NEC®* Article 500.6(B)(2) and *NFPA*-499 Article 3.3.4.2].

Thus, the fitting must be marked for Class II, Division 1, Group F suitability.

**THE CORRECT ANSWER IS: Class II, Division 1, Group F**
71. \[ I_{\text{TRANSFER}} = \frac{500 \angle 90^\circ - 500 \angle 0^\circ}{\sqrt{3}(50 \angle 90^\circ)} \]
   \[ = \frac{j500 - 500}{\sqrt{3}(j50)} \]
   \[ = 8,165 \angle 45^\circ \text{ A} \]
   \[ \text{VAR} = (3)(8.165)^2 (50) \]
   \[ = 10,000 \text{ Mvar} \]

**THE CORRECT ANSWER IS: (D)**

72. \[ I_{\text{CT}} = \frac{320}{800} (5) = 2.0 \text{ A} \]

**THE CORRECT ANSWER IS: (B)**

73. \[ I_{N3H} = \sum I_{N3H} \]
   \[ = 3 (3) = 9 \text{ A} \]

**THE CORRECT ANSWER IS: (C)**

74. When the fault is applied, the electrical power \( P_e \) goes to the zero, but the mechanical power \( P_m \) remains constant. This causes the rotor to accelerate with the additional kinetic energy stored in the rotating inertia of the rotor until the fault is cleared at \( \delta_1 \) and the additional kinetic energy can be released into the grid. Area C is proportional to the kinetic energy added to the rotor during the fault. This is described in the Power System Stability section in the *PE Electrical and Computer: Power Reference Handbook*.

**THE CORRECT ANSWER IS: Area C**