PRACTICE EXAM 19: FE ELECTRICAL AND COMPUTER SIMULATION (110 QUESTIONS)

Time allotted: 5 hours 20 minutes

Materials: NCEES-approved calculator + NCEES FE Reference Handbook only

1. What is the derivative of $f(x) = \cos(x)$?

A. $\cos(x)$

B. $-\sin(x)$

C. $\sin(x)$

D. $-\cos(x)$

2. Evaluate $\int 6x^2\,dx$.

A. $12x + C$

B. $6x^3 + C$

C. $3x^2 + C$

D. $2x^3 + C$

3. The magnitude of the complex number $3 + 4j$ is:

A. 5

B. 7

C. 1

D. 25

4. Solve for x: $2x + 6 = 0$.

A. 6

B. 3

C. -3

D. -6

5. Evaluate $\sin(90°)$.

A. 0

B. 1

C. -1

D. 0.5

6. The slope of the line $y = 5x - 2$ is:

A. 5

B. −2

C. 2

D. −5

7. Evaluate $\int_0^1 3x^2\,dx$.

A. 3

B. 6

C. 0

D. 1

8. The dot product of vectors (1, 2) and (3, 4) is:

A. 4

B. 7

C. 11

D. 14

9. The value of $\log_2(8)$ is:

A. 2

B. 8

C. 3

D. 16

10. The limit $\lim(x\to\infty)\ (3x + 1)/x$ equals:

A. 1

B. 3

C. ∞

D. 0

11. The solution to the equation $e^x = 1$ is:

A. 1

B. e

C. 0

D. -1

12. The sum of the interior angles of a triangle is:

A. 180°

B. 360°

C. 90°

D. 270°

13. Two fair coins are tossed. The probability of getting two heads is:

A. 1/2

B. 1/3

C. 1

D. 1/4

14. The mean of the data set 2, 4, 6, 8 is:

A. 4

B. 5

C. 6

D. 20

15. The standard deviation of a data set is the square root of the:

A. Variance

B. Mean

C. Median

D. Range

16. The number of ways to arrange 3 distinct books on a shelf is:

A. 3

B. 9

C. 27

D. 6

17. In a normal distribution, approximately what percentage of data falls within one standard deviation of the mean?

A. 68%

B. 95%

C. 50%

D. 99.7%

18. Under the NSPE Code, an engineer should accept assignments only when they are:

A. Highly profitable regardless of expertise

B. Qualified by education or experience in the field

C. Approved by a marketing department

D. Outside their area of competence for growth

19. An engineer receiving a gift of significant value from a vendor seeking a contract should:

A. Accept it as a normal business courtesy

B. Accept it and disclose nothing to the employer

C. Decline it to avoid a conflict of interest

D. Accept it only if it is given in cash

20. Under the NSPE Code, statements made by engineers in public on technical matters must be:

A. Objective and truthful

B. Favorable to their employer

C. Limited to non-technical opinions

D. Withheld unless legally required

21. An engineer asked to seal plans they did not prepare or supervise should:

A. Seal them to expedite the project

B. Seal them if paid an additional fee

C. Seal them if the original engineer agrees

D. Refuse to seal work not done under their charge

22. A sum of $2,000 invested at 5% compounded annually grows in one year to:

A. $2,005

B. $2,500

C. $2,100

D. $2,050

23. The depreciation method that writes off an equal amount each year is the:

A. Declining balance method

B. Straight-line method

C. Sum-of-years-digits method

D. Units-of-production method

24. The point at which total revenue equals total cost is the:

A. Break-even point

B. Salvage value

C. Sunk cost

D. Margin of safety

25. A cost already incurred that cannot be recovered and should not affect future decisions is a:

A. Marginal cost

B. Variable cost

C. Opportunity cost

D. Sunk cost

26. The rate of return at which the net present worth of a project equals zero is the:

A. Minimum attractive rate of return

B. Nominal interest rate

C. Inflation rate

D. Internal rate of return

27. The property of a material that opposes the flow of electric current is its:

A. Conductance

B. Permeability

C. Resistivity

D. Permittivity

28. Doping a pure semiconductor with a trivalent impurity (such as boron) produces a material that is:

A. P-type

B. N-type

C. Intrinsic

D. Superconducting

29. As temperature rises, the resistance of a typical metallic conductor:

A. Decreases

B. Increases

C. Remains constant

D. Drops to zero

30. A dielectric material placed between capacitor plates serves to:

A. Conduct current between the plates

B. Increase the capacitance

C. Decrease the stored charge

D. Short-circuit the plates

31. A resistor carries 2 A when 10 V is applied. Its resistance is:

A. 5 Ω

B. 20 Ω

C. 0.2 Ω

D. 12 Ω

32. Two 6 Ω resistors connected in parallel have an equivalent resistance of:

A. 12 Ω

B. 6 Ω

C. 3 Ω

D. 0.33 Ω

33. The energy stored in a 2 F capacitor charged to 3 V is:

A. 3 J

B. 6 J

C. 18 J

D. 9 J

34. Kirchhoff's voltage law states that the sum of voltages around a closed loop equals:

A. The source voltage

B. Zero

C. The total resistance

D. The current

35. The time constant of a series RC circuit with R = 1 kΩ and C = 2 μF is:

A. 2 ms

B. 0.5 ms

C. 500 s

D. 2 s

36. In a series circuit, the current through each component is:

A. Inversely proportional to resistance

B. Divided among components

C. Zero in the largest resistor

D. The same throughout

37. The inductive reactance of a 0.1 H inductor at 60 Hz is approximately:

A. 6 Ω

B. 0.1 Ω

C. 37.7 Ω

D. 377 Ω

38. In an AC circuit, the average power consumed by an ideal (lossless) inductor over a full cycle is:

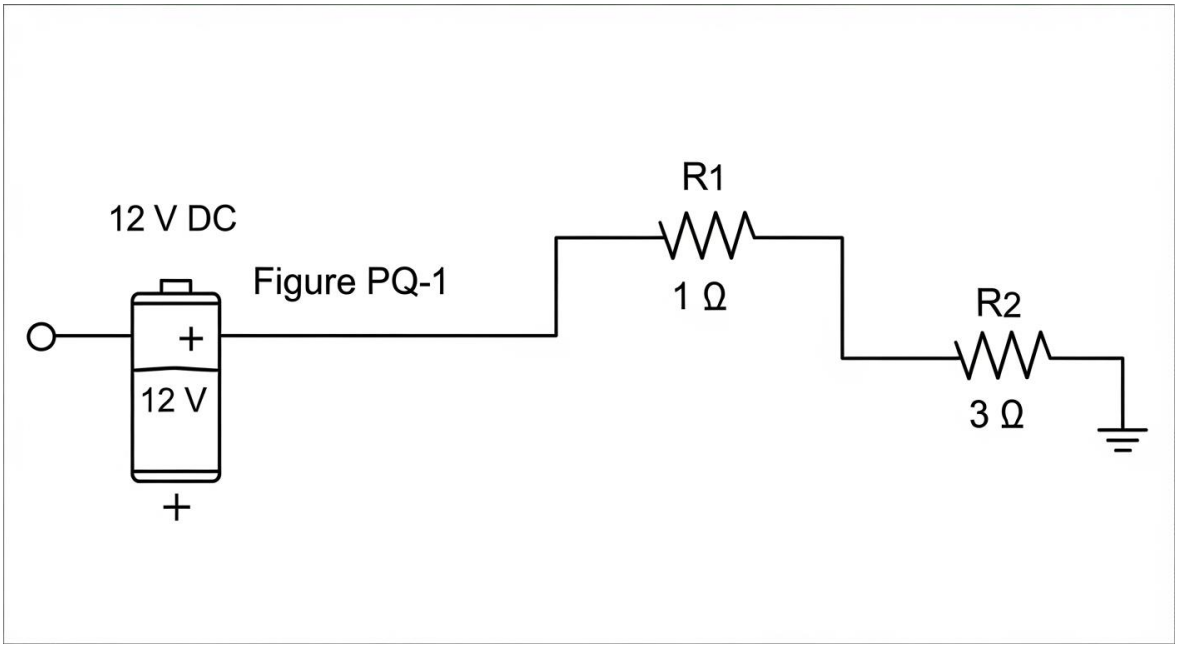
A. Maximum

B. Zero

C. Equal to V×I

D. Half of V×I

39. In the circuit shown, what is the voltage across the 3 Ω resistor?



A. 12 V

B. 3 V

C. 4 V

D. 9 V

40. The superposition theorem can be applied only to circuits that are:

A. Linear

B. Purely resistive

C. Single-source

D. Nonlinear

41. Norton's theorem represents a network as a current source in parallel with a:

A. Voltage source

B. Capacitor

C. Resistance

D. Inductor

42. The phase relationship between voltage and current in a purely capacitive AC circuit is that current:

A. Lags voltage by 90°

B. Leads voltage by 90°

C. Is in phase with voltage

D. Leads voltage by 45°

43. A 10 Ω resistor dissipates 40 W. The current through it is:

A. 2 A

B. 4 A

C. 0.25 A

D. 20 A

44. The Laplace transform of a unit impulse $\delta(t)$ is:

A. $1/s$

B. $1/s^2$

C. s

D. 1

45. A system whose present output depends on future inputs is:

A. Stable

B. Linear

C. Time-invariant

D. Non-causal

46. The poles of a transfer function determine the system's:

A. Input amplitude

B. Natural response and stability

C. DC offset only

D. Physical dimensions

47. The frequency of the signal $x(t) = \sin(200\pi t)$ is:

A. 200 Hz

B. 50 Hz

C. 100 Hz

D. 400 Hz

48. Convolution in the time domain corresponds in the frequency domain to:

A. Multiplication

B. Addition

C. Convolution

D. Division

49. A signal sampled below the Nyquist rate experiences:

A. Amplification

B. Aliasing

C. A pure delay

D. No distortion

50. The transfer function of a system is the ratio of output to input in the:

A. Time domain

B. Spatial domain

C. s-domain (with zero initial conditions)

D. Probability domain

51. An ideal low-pass filter passes frequencies:

A. Above the cutoff only

B. In a narrow band only

C. At a single frequency only

D. Below the cutoff only

52. For a discrete-time system to be stable (BIBO), its impulse response must be:

A. Absolutely summable

B. Periodic

C. Strictly increasing

D. Non-zero everywhere

53. The Fourier transform of a time-domain signal provides its:

A. Time delay

B. Frequency spectrum

C. Power supply rating

D. Phase margin only

54. Increasing the sampling frequency of an ADC, for a fixed input, generally:

A. Causes more aliasing

B. Reduces the bit depth

C. Better preserves the signal

D. Eliminates quantization

55. The step response of a system is its output when the input is a:

A. Sinusoid

B. Impulse

C. Ramp

D. Unit step

56. The voltage gain of an ideal inverting op-amp amplifier with $R_f = 100\ k\Omega$ and $R_{in} = 10\ k\Omega$ is:

A. −10

B. −0.1

C. +10

D. +11

57. In a common-emitter BJT amplifier, the output signal is:

A. In phase with the input

B. Equal in amplitude to the input

C. 180° out of phase with the input

D. A DC level only

58. The threshold voltage of a MOSFET is the gate-source voltage at which the device:

A. Reaches breakdown

B. Begins to conduct (forms a channel)

C. Saturates the supply

D. Turns fully off

59. A full-wave rectifier produces an output ripple frequency that is _____ the input frequency.

A. Twice

B. Half

C. Equal to

D. One quarter of

60. The forward voltage drop of a typical silicon diode is approximately:

A. 0 V

B. 5 V

C. 1.5 V

D. 0.7 V

61. An ideal op-amp has an open-loop gain that is:

A. Exactly one

B. Infinite

C. Zero

D. Negative

62. A photodiode operated in photoconductive mode is typically:

A. Forward biased heavily

B. Unbiased always

C. Reverse biased

D. Operated in breakdown

63. For the non-inverting amplifier shown, what is the output voltage V_out?

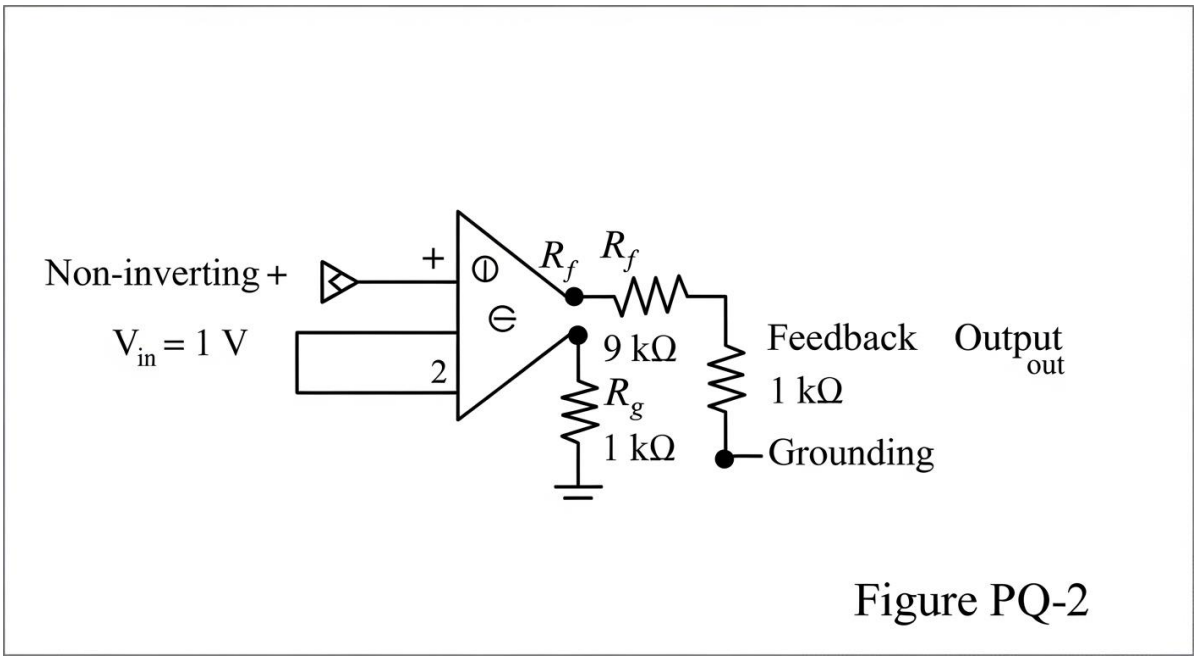


Figure PQ-2

A. 1 V

B. 9 V

C. −9 V

D. 10 V

64. A single-phase load draws 10 A at 230 V with a power factor of 1. The real power is:

A. 2300 W

B. 230 W

C. 23 W

D. 2.3 W

65. An ideal transformer conserves which quantity between primary and secondary?

A. Voltage

B. Apparent power

C. Current

D. Number of turns

66. The purpose of laminating a transformer core is to reduce:

A. Copper losses

B. Hysteresis losses

C. Eddy current losses

D. Leakage flux

67. A 4-pole induction motor on a 60 Hz supply has a synchronous speed of:

A. 1800 rpm

B. 3600 rpm

C. 900 rpm

D. 1200 rpm

68. In a balanced three-phase wye (star) system, the line voltage equals the phase voltage multiplied by:

A. 1

B. 2

C. 3

D. $\sqrt{3}$

69. The power factor of a load is defined as the ratio of:

A. Apparent power to real power

B. Reactive power to real power

C. Real power to apparent power

D. Voltage to current

70. A DC motor's speed can be increased by:

A. Increasing the field flux

B. Increasing the armature voltage

C. Adding mechanical load

D. Reducing the supply voltage

71. The reactive power in an AC system is measured in:

A. VAR

B. Watts

C. Joules

D. Henrys

72. A transformer rated 10 kVA, 240/120 V can supply a maximum secondary current of approximately:

A. 10 A

B. 24 A

C. 41.7 A

D. 83.3 A

73. According to Faraday's law, an EMF is induced in a coil by a changing:

A. Resistance

B. Magnetic flux

C. Temperature

D. Capacitance

74. The direction of an induced current opposes the change producing it, as stated by:

A. Ohm's law

B. Coulomb's law

C. Lenz's law

D. Gauss's law

75. The SI unit of magnetic flux density is the:

A. Tesla

B. Weber

C. Henry

D. Farad

76. The speed of an electromagnetic wave in free space is approximately:

A. 3×10^6 m/s

B. 3×10^5 m/s

C. 3×10^{10} m/s

D. 3×10^{8} m/s

77. The order of a control system is determined by the:

A. Number of inputs

B. Highest power of s in the denominator

C. Number of zeros

D. DC gain value

78. A system with a damping ratio between 0 and 1 is:

A. Overdamped

B. Critically damped

C. Underdamped

D. Undamped

79. The steady-state error of a system to a step input is reduced by adding:

A. A differentiator only

B. A series resistor

C. More zeros

D. Integral control

80. The Routh-Hurwitz criterion is used to determine a system's:

A. Stability

B. Steady-state gain

C. Bandwidth

D. Rise time

81. The gain margin of a stable feedback system is a measure of:

A. The system's bandwidth

B. The steady-state error

C. How much gain can increase before instability

D. The number of poles

82. In a block diagram, a summing junction is used to:

A. Multiply two signals

B. Add or subtract signals

C. Integrate a signal

D. Delay a signal

83. A closed-loop control system differs from an open-loop system in that it uses:

A. Feedback of the output

B. A larger power supply

C. No controller

D. Only manual adjustment

84. In amplitude modulation (AM), the information is carried in the carrier's:

A. Frequency

B. Phase

C. Polarization

D. Amplitude

85. The Nyquist sampling theorem requires the sampling rate to be at least:

A. Equal to the highest frequency

B. Half the highest frequency

C. Twice the highest frequency

D. Four times the highest frequency

86. Pulse code modulation (PCM) converts an analog signal into a:

A. Continuous waveform

B. Digital bit stream

C. Single sinusoid

D. Frequency-modulated wave

87. The bandwidth required for a communication channel generally increases with the:

A. Carrier phase

B. Cable color

C. Antenna height

D. Data rate

88. A modem performs the functions of:

A. Modulation and demodulation

B. Amplification only

C. Encryption only

D. Power regulation

89. The protocol responsible for translating domain names into IP addresses is:

A. FTP

B. DNS

C. HTTP

D. SMTP

90. The transport-layer protocol that guarantees reliable, ordered delivery is:

A. UDP

B. IP

C. TCP

D. ARP

91. A subnet mask is used to separate an IP address into network and:

A. Host portions

B. Port numbers

C. MAC addresses

D. Protocol types

92. In the OSI model, encryption and data formatting are handled at the:

A. Physical layer

B. Network layer

C. Transport layer

D. Presentation layer

93. Convert the decimal number 10 to binary.

A. 1000

B. 1100

C. 1010

D. 1001

94. The Boolean expression A · 1 simplifies to:

A. 1

B. A

C. 0

D. A'

95. A NOR gate produces a HIGH output only when all its inputs are:

A. LOW

B. HIGH

C. Different

D. Floating

96. The number of distinct output states of a 3-bit binary counter is:

A. 3

B. 6

C. 4

D. 8

97. Convert the binary number 111 to decimal.

A. 6

B. 7

C. 8

D. 3

98. A decoder with 3 input lines can activate at most how many output lines?

A. 3

B. 6

C. 8

D. 4

99. The 2's complement of the 4-bit binary number 0001 is:

A. 1111

B. 0001

C. 1110

D. 0000

100. In Boolean algebra, the expression A + A' equals:

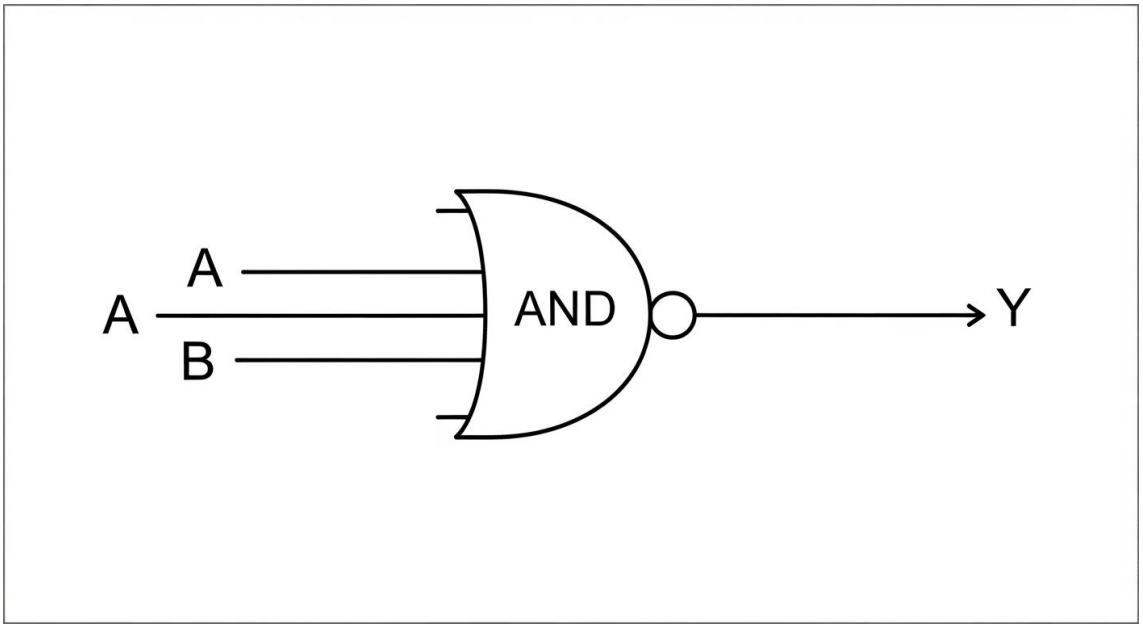
A. A

B. 0

C. A'

D. 1

101. For the logic gate shown, what is the output Y when both inputs A and B are HIGH (1)?



A. 0

B. 1

C. High impedance

D. Undefined

102. The component that holds data and instructions currently being used by the CPU is the:

A. Hard disk

B. Optical drive

C. Main memory (RAM)

D. Power supply

103. Cache memory is used in a computer system to:

A. Speed up access to frequently used data

B. Permanently store the operating system

C. Replace the hard disk entirely

D. Cool the processor

104. The binary instruction format directly executed by a CPU is called:

A. Source code

B. Assembly mnemonics

C. High-level code

D. Machine code

105. A byte consists of how many bits?

A. 4

B. 8

C. 16

D. 32

106. The bus that carries the addresses of memory locations to be accessed is the:

A. Address bus

B. Data bus

C. Control bus

D. Power bus

107. A "for" loop in programming is primarily used to:

A. Store a value permanently

B. Make a single decision

C. Repeat a block a known number of times

D. Define a new data type

108. The process of finding and fixing errors in code is called:

A. Compiling

B. Linking

C. Encrypting

D. Debugging

109. An array stores a collection of elements that are:

A. Of different unrelated types always

B. Of the same type, accessed by index

C. Never able to be changed

D. Stored only on disk

110. The time complexity of binary search on a sorted array of n elements is:

A. O(n)

B. $O(n^2)$

C. O(log n)

D. O(1)

PRACTICE EXAM 19 — ANSWER KEY AND FULL ANSWER EXPLANATIONS

1. B — The derivative of cos(x) is −sin(x). The sine appears with a negative sign because cosine decreases as the angle increases from zero.

2. D — Applying the reverse power rule, $\int 6x^2\,dx = 6 \cdot x^3/3 + C = 2x^3 + C$. The exponent increases by one and divides the coefficient.

3. A — The magnitude of a + bj is $\sqrt{(a^2 + b^2)} = \sqrt{(3^2 + 4^2)} = \sqrt{25} = 5$. This is the hypotenuse of the 3-4-5 right triangle in the complex plane.

4. C — Subtracting 6 gives $2x = -6$, so $x = -3$. Isolating x solves the linear equation.

5. B — sin(90°) = 1, the maximum value of the sine function. It occurs at the peak of the sine curve.

6. A — In slope-intercept form y = mx + b, the coefficient of x is the slope, here 5. The −2 is the y-intercept.

7. D — $\int_0^1 3x^2\,dx = x^3$ evaluated from 0 to 1 = 1 − 0 = 1. The antiderivative of $3x^2$ is x^3.

8. C — The dot product is (1)(3) + (2)(4) = 3 + 8 = 11. Corresponding components are multiplied and summed.

9. C — $\log_2(8)$ asks the power of 2 that gives 8; since $2^3 = 8$, the answer is 3. Logarithms return the exponent.

10. B — As x grows large, the ratio (3x + 1)/x approaches the ratio of leading coefficients, 3. The lower-order term becomes negligible.

11. C — $e^x = 1$ requires the exponent to be zero, since any base to the zero power is 1, so x = 0. The natural exponential equals one only at zero.

12. A — The interior angles of any triangle sum to 180°. This is a fundamental result of Euclidean geometry.

13. D — Each coin shows heads with probability 1/2, and for independent events the probabilities multiply: 1/2 × 1/2 = 1/4. Independence allows the product rule.

14. B — The mean is (2 + 4 + 6 + 8)/4 = 20/4 = 5. The mean is the sum divided by the count.

15. A — Standard deviation is the square root of the variance, returning the spread to the original units. Variance is the mean of the squared deviations.

16. D — The number of arrangements of 3 distinct items is $3! = 3 \times 2 \times 1 = 6$. Each ordering is a distinct permutation.

17. A — In a normal distribution, about 68% of the data lie within one standard deviation of the mean. This is the first part of the empirical (68-95-99.7) rule.

18. B — The NSPE Code directs engineers to perform services only in their areas of competence, established by education or experience. Working outside one's competence risks public safety.

19. C — Accepting a valuable gift from a vendor seeking a contract creates a conflict of interest, so the engineer should decline. The Code requires avoiding even the appearance of compromised judgment.

20. A — The NSPE Code requires that public statements on technical matters be objective and truthful. Misleading statements undermine public trust and safety.

21. D — An engineer must seal only work performed by them or under their responsible charge, so they must refuse to seal plans they did not prepare or supervise. The seal certifies professional accountability.

22. C — Compound growth for one year is $2{,}000 \times (1 + 0.05) = \$2{,}100$. The first year's compound and simple interest are identical.

23. B — Straight-line depreciation allocates an equal amount of an asset's cost to each year of its life. It is the simplest depreciation method.

24. A — The break-even point is where total revenue equals total cost, yielding zero profit. Output beyond it generates profit.

25. D — A sunk cost is already spent and unrecoverable, so it should not influence future decisions. Only future costs and benefits are relevant to a decision.

26. D — The internal rate of return is the discount rate that makes a project's net present worth zero. It measures the project's intrinsic earning rate.

27. C — Resistivity is the intrinsic material property that opposes current flow, independent of size or shape. Resistance is resistivity scaled by geometry.

28. A — A trivalent dopant such as boron contributes holes, creating a P-type semiconductor. Holes are the majority carriers in P-type material.

29. B — In a metallic conductor, rising temperature increases lattice vibrations that scatter electrons, raising resistance. Metals have a positive temperature coefficient.

30. B — A dielectric increases capacitance by reducing the effective field, allowing more charge to be stored at a given voltage. Its relative permittivity multiplies the capacitance.

31. A — By Ohm's law, $R = V/I = 10/2 = 5\ \Omega$. Resistance is voltage divided by current.

32. C — Two equal resistors in parallel give half the value: 6/2 = 3 Ω. Parallel paths reduce the equivalent resistance.

33. D — Energy stored is ½CV² = ½ × 2 × 3² = ½ × 2 × 9 = 9 J. Energy scales with the square of the voltage.

34. B — Kirchhoff's voltage law states that the algebraic sum of voltages around any closed loop is zero. It expresses conservation of energy.

35. A — The time constant is $\tau = RC = 1{,}000 \times 2\times10^{-6} = 2\times10^{-3}$ s = 2 ms. It sets the charging and discharging rate.

36. D — In a series circuit there is a single path, so the same current flows through every component. Current is common in series.

37. C — Inductive reactance is $X_L = 2\pi fL = 2\pi \times 60 \times 0.1 \approx 37.7$ Ω. It rises with frequency and inductance.

38. B — An ideal inductor stores and returns energy each cycle, so its average real power over a full cycle is zero. It consumes only reactive power.

39. D — The series current is I = 12/(1 + 3) = 3 A, and the voltage across the 3 Ω resistor is 3 × 3 = 9 V. The larger resistor drops the larger share of the source.

40. A — Superposition applies only to linear circuits, where responses to individual sources add. Nonlinear elements violate the additivity it relies on.

41. C — Norton's theorem models a network as a current source in parallel with a resistance. It is the dual of Thévenin's voltage-source form.

42. B — In a purely capacitive circuit the current leads the voltage by 90°, since current depends on the rate of change of voltage. The capacitor must charge before its voltage rises.

43. A — From $P = I^2R$, $I = \sqrt{(P/R)} = \sqrt{(40/10)} = \sqrt{4} = 2$ A. The current is the square root of power over resistance.

44. D — The Laplace transform of the unit impulse δ(t) is 1, since the impulse has unit area concentrated at the origin. This makes it the identity for convolution.

45. D — A system whose present output depends on future input is non-causal, because it anticipates inputs that have not yet occurred. Real-time physical systems must be causal.

46. B — The poles of a transfer function set the system's natural (transient) response and determine its stability. Poles in the left-half plane indicate a stable system.

47. C — With $\omega = 200\pi$, the frequency is $f = \omega/(2\pi) = 200\pi/(2\pi) = 100$ Hz. Dividing the angular frequency by 2π gives the cyclic frequency.

48. A — Convolution in the time domain becomes multiplication in the frequency domain. This property greatly simplifies the analysis of LTI systems.

49. B — Sampling below the Nyquist rate causes aliasing, where high frequencies masquerade as lower ones. The original signal can no longer be recovered.

50. C — The transfer function is the ratio of output to input Laplace transforms in the s-domain, with zero initial conditions. It characterizes an LTI system algebraically.

51. D — An ideal low-pass filter passes all frequencies below its cutoff and blocks those above. It is the complement of a high-pass filter.

52. A — A discrete-time system is BIBO stable if and only if its impulse response is absolutely summable. Bounded inputs then produce bounded outputs.

53. B — The Fourier transform decomposes a time-domain signal into its frequency spectrum. It reveals the frequency content of the signal.

54. C — A higher sampling frequency captures more detail of a fixed input, better preserving the signal and easing anti-alias filtering. Oversampling improves reconstruction fidelity.

55. D — The step response is the output produced when the input is a unit step. It reveals both transient and steady-state behavior to a sudden change.

56. A — The inverting amplifier gain is $-R_f/R_{in} = -100\ \text{k}\Omega/10\ \text{k}\Omega = -10$. The negative sign reflects the 180° phase inversion.

57. C — A common-emitter amplifier inverts the signal, producing an output 180° out of phase with the input. The collector voltage falls as the base drive rises.

58. B — The threshold voltage is the gate-source voltage at which a MOSFET begins to form a conducting channel. Below it, the device is essentially off.

59. A — A full-wave rectifier produces two output pulses per input cycle, so its ripple frequency is twice the input frequency. Both half-cycles contribute to the output.

60. D — A forward-biased silicon diode drops about 0.7 V across its junction. This is the characteristic turn-on voltage of silicon.

61. B — An ideal op-amp has infinite open-loop gain, which is what forces the inputs to equal voltage under negative feedback. Real op-amps approximate this with very large gain.

62. C — A photodiode in photoconductive mode is reverse biased, widening the depletion region for faster response and lower capacitance. Incident light then generates a measurable reverse current.

63. D — The non-inverting gain is $1 + R_f/R_g = 1 + 9\ k\Omega/1\ k\Omega = 10$, so $V_{out} = 10 \times 1\ V = 10\ V$. The output is in phase with and larger than the input.

64. A — Real power is $P = VI \cdot pf = 230 \times 10 \times 1 = 2{,}300\ W$. With unity power factor, all the apparent power is real.

65. B — An ideal transformer conserves apparent power, so $V_pI_p = V_sI_s$. Voltage and current change inversely with the turns ratio.

66. C — Laminating the core breaks up the paths for circulating eddy currents, reducing eddy current losses. Thin insulated layers raise the resistance to these currents.

67. A — Synchronous speed is $120f/P = 120 \times 60/4 = 1{,}800$ rpm. The rotor of an induction motor runs slightly below this.

68. D — In a wye system, the line voltage equals $\sqrt{3}$ times the phase voltage. The line and phase currents are equal in wye.

69. C — Power factor is the ratio of real power to apparent power, equal to the cosine of the phase angle. It indicates how effectively current produces useful work.

70. B — A DC motor's speed rises with applied armature voltage, since back-EMF must increase to match. Reducing field flux also raises speed, but increasing flux lowers it.

71. A — Reactive power is measured in volt-amperes reactive (VAR). It represents energy exchanged with reactive elements rather than dissipated.

72. D — Secondary current capacity is $S/V = 10{,}000/120 \approx 83.3$ A. The kVA rating divided by the secondary voltage gives the maximum current.

73. B — Faraday's law states that a changing magnetic flux through a coil induces an EMF. The induced voltage is proportional to the rate of flux change.

74. C — Lenz's law states that an induced current flows so as to oppose the change in flux that produced it. It is a consequence of energy conservation.

75. A — The tesla is the SI unit of magnetic flux density (B). One tesla equals one weber per square meter.

76. D — Electromagnetic waves travel at about 3×10^8 m/s in free space, the speed of light. All electromagnetic radiation shares this speed in vacuum.

77. B — The order of a system equals the highest power of s in the denominator of its transfer function. It corresponds to the number of poles.

78. C — A damping ratio between 0 and 1 produces an underdamped response that oscillates while decaying. The system overshoots before settling.

79. D — Adding integral control eliminates steady-state error by accumulating error until it is driven to zero. Integral action raises the system type.

80. A — The Routh-Hurwitz criterion determines stability from the coefficients of the characteristic equation without solving for the roots. Sign changes in the first column indicate right-half-plane poles.

81. C — Gain margin measures how much the loop gain can increase before the system becomes unstable. It is read where the phase crosses −180°.

82. B — A summing junction adds or subtracts the signals entering it, according to the signs at each input. It combines the reference and feedback in a control loop.

83. A — A closed-loop system uses feedback of the output to adjust the input, unlike an open-loop system. Feedback improves accuracy and disturbance rejection.

84. D — In amplitude modulation, the message varies the amplitude of the carrier while its frequency stays fixed. The envelope of the carrier carries the information.

85. C — The Nyquist theorem requires sampling at least twice the highest signal frequency. This rate prevents aliasing and allows exact reconstruction.

86. B — Pulse code modulation samples, quantizes, and encodes an analog signal into a digital bit stream. It is the basis of digital audio and telephony.

87. D — Higher data rates require greater bandwidth, as more information per second demands a wider frequency range. Bandwidth and data rate rise together.

88. A — A modem modulates outgoing digital data onto a carrier and demodulates incoming signals back to digital. Its name combines modulator and demodulator.

89. B — The Domain Name System translates human-readable domain names into numerical IP addresses. It acts as the internet's directory service.

90. C — TCP provides reliable, ordered, connection-oriented delivery with acknowledgments and retransmission. UDP, by contrast, is connectionless and unreliable.

91. A — A subnet mask divides an IP address into its network portion and its host portion. The mask's one-bits mark the network part.

92. D — The presentation layer handles data formatting, encryption, and translation between representations. It prepares data for the application layer.

93. C — Decimal 10 = 8 + 2 = 1010 in binary, setting the 2^3 and 2^1 places. Each position is a power of two.

94. B — A AND'd with 1 leaves A unchanged: $A \cdot 1 = A$. One is the identity element for AND.

95. A — A NOR gate outputs HIGH only when all inputs are LOW, since it is the negation of OR. Any HIGH input forces the output LOW.

96. D — A 3-bit counter cycles through $2^3 = 8$ distinct states, from 000 to 111. Each bit doubles the number of states.

97. B — Binary 111 = 4 + 2 + 1 = 7 in decimal. All three bit positions are set.

98. C — A 3-to-8 decoder activates one of $2^3 = 8$ output lines for each input combination. The number of outputs is two raised to the number of inputs.

99. A — The 2's complement of 0001 is found by inverting to 1110 and adding 1, giving 1111. This represents −1 in 4-bit signed form.

100. D — A variable OR'd with its complement always equals 1, since one of them must be true. This is the complement law.

101. B — An AND gate outputs 1 only when all inputs are 1, so with A = B = 1 the output Y is 1. Any LOW input would force the output LOW.

102. C — Main memory (RAM) holds the data and instructions the CPU is actively using. Its fast, volatile storage feeds the processor.

103. A — Cache memory speeds access to frequently used data by holding it in fast storage near the CPU. It bridges the speed gap between the processor and main memory.

104. D — Machine code is the binary instruction format the CPU executes directly. Higher-level code must be translated into it before execution.

105. B — A byte consists of 8 bits, the standard unit for representing a character. It can encode 256 distinct values.

106. A — The address bus carries the memory addresses the CPU wishes to access. Its width sets the maximum addressable memory.

107. C — A "for" loop repeats a block a known, counted number of times. It is the standard construct for definite iteration.

108. D — Debugging is the process of locating and correcting errors in code. It restores the program to correct operation.

109. B — An array stores a collection of elements of the same type, each accessed by an index. The index gives direct, constant-time access.

110. C — Binary search halves the search interval each step, giving O(log n) time on a sorted array. Each comparison eliminates half the remaining elements.