# PRACTICE EXAM 6 (110 QUESTIONS)

1. The derivative of $f(x) = 5x^3$ with respect to x is:

A. $5x^2$

B. $15x^2$

C. $15x^3$

D. $5x^4$

2. A complex number $z = 10\angle 53.13°$ is converted to rectangular form. Its components are approximately:

A. 10 + j0

B. 0 + j10

C. 8 + j10

D. 6 + j8

3. The integral of $f(x) = 6x$ with respect to x is:

A. 6 + C

B. $6x^2 + C$

C. $3x^2 + C$

D. $12x^2 + C$

4. A vector dot product of two vectors equals zero. The vectors are:

A. Parallel and aligned

B. Of equal magnitude

C. Both zero vectors

D. Perpendicular to each other

5. A second-order system has two distinct negative real roots. Its response is:

A. Underdamped with oscillation

B. Critically damped and fastest

C. Unstable and growing

D. Overdamped without oscillation

6. The data set {5, 10, 10, 15, 20} has a mean of:

A. 10

B. 12

C. 15

D. 20

7. For a normal distribution, approximately 68% of values lie within how many standard deviations of the mean?

A. One

B. Two

C. Three

D. Half

8. An investment pays \$1,500 with probability 0.4 and \$0 with probability 0.6. The expected value is:

A. \$1,500

B. \$900

C. \$300

D. \$600

9. A present sum of \$2,000 at 10% compounded annually grows in 1 year to:

A. \$2,000

B. \$2,200

C. \$2,020

D. \$1,800

10. A benefit-cost ratio of 0.75 indicates that a project's:

A. Benefits strongly justify it

B. Benefits equal its costs

C. Value doubles over time

D. Costs exceed its benefits

11. An engineer must disclose a financial interest in a firm bidding on their project. This duty stems from the obligation to:

A. Act as a faithful agent

B. Maximize personal profit

C. Complete work quickly

D. Avoid all outside investments

12. A patent for an invention typically provides exclusive rights for a limited term of about:

A. 20 years from filing

B. 5 years from filing

C. 50 years from filing

D. An unlimited duration

13. An engineer may seal engineering documents only if the work was:

A. Reviewed once by any colleague

B. Produced anywhere in the company

C. Prepared under their direct supervision

D. Verbally approved by a manager

14. A semiconductor doped with acceptor atoms conducts primarily through:

A. Free electrons in the conduction band

B. Neutral migrating dopants

C. Holes acting as positive carriers

D. Photons emitted by the lattice

15. Permittivity is the material property that most directly governs a:

A. Resistor's heat dissipation

B. Capacitor's charge storage

C. Inductor's magnetic energy

D. Diode's forward drop

16. Heating a silicon semiconductor sample causes its resistance to:

A. Decrease as carriers cross the gap

B. Increase due to atomic vibration

C. Remain perfectly constant

D. Rise abruptly without limit

17. A p-n junction under forward bias has a depletion region that:

A. Widens, blocking current

B. Narrows, allowing current

C. Stays the same width

D. Becomes an insulator

18. Kirchhoff's Voltage Law expresses the conservation of:

A. Charge at a node

B. Energy around a loop

C. Magnetic flux in a core

D. Current through a branch

19. Three resistors of 9 Ω each in parallel give an equivalent resistance of:

A. 3 Ω

B. 9 Ω

C. 27 Ω

D. 18 Ω

20. When finding a Thevenin resistance, an ideal current source is replaced with:

A. A short circuit

B. A 1 Ω resistor

C. A voltage source

D. An open circuit

21. A sinusoid has a peak value of 100 V. Its RMS value is approximately:

A. 141 V

B. 70.7 V

C. 100 V

D. 50 V

22. The impedance of an ideal capacitor at angular frequency ω is:

A. jωL

B. 1/(jωC)

C. R only

D. Zero always

23. Nodal analysis applies Kirchhoff's Current Law to solve for:

A. Branch currents directly

B. Total dissipated power

C. Magnetic flux per loop

D. Node voltages relative to a reference

24. Capacitive reactance changes with frequency in that it:

A. Increases with frequency

B. Stays constant always

C. Becomes infinite at high frequency

D. Decreases as frequency rises

25. In the mnemonic "ELI the ICE man," the inductor portion (ELI) indicates that:

A. Current leads voltage by 90°

B. Voltage and current are in phase

C. Voltage leads current by 90°

D. They are 180° apart

26. The total response of a linear system equals the sum of the transient response and the:

A. Steady-state response

B. Input noise signal

C. Reverse response

D. DC offset only

27. At series resonance, the impedance of an RLC circuit is:

A. Maximum and reactive

B. Infinite, blocking current

C. Minimum and purely resistive

D. Negative and capacitive

28. A high quality factor Q indicates a resonant circuit with a:

A. Broad, shallow response

B. Resonant frequency near zero

C. Narrow, sharp response

D. Purely reactive impedance

29. The Laplace transform converts time-domain differentiation into:

A. Division by s

B. Addition of a constant

C. An integration step

D. Multiplication by s

30. A transfer function's zeros are the values of s that make its:

A. Numerator polynomial zero

B. Denominator polynomial zero

C. Gain margin infinite

D. Phase margin zero

31. The Nyquist theorem requires a sampling rate of at least:

A. Twice the highest signal frequency

B. Half the highest frequency

C. Equal to the highest frequency

D. Four times for safety

32. Aliasing in a sampled signal results from sampling:

A. Far above the Nyquist rate

B. Below the Nyquist rate

C. Exactly at the Nyquist rate

D. With an ideal filter

33. A low-pass filter passes:

A. High frequencies, blocking low

B. Low frequencies, blocking high

C. A single narrow band

D. No frequencies at all

34. The cutoff frequency of a filter is where output power falls to:

A. Half its passband value

B. Twice its passband value

C. One-tenth its value

D. Zero across the band

35. A digital filter operating on sampled data is analyzed using the:

A. Fourier series only

B. Laplace transform

C. Power triangle

D. Z-transform

36. A conducting silicon diode is modeled for exam analysis with a forward drop of:

A. 0.0 V, ideal

B. 5.0 V, large

C. 12.0 V, the supply

D. 0.7 V, constant

37. A Zener diode is designed to operate in:

A. Forward conduction only

B. Reverse breakdown

C. Cutoff with no current

D. The active region

38. A bipolar junction transistor (BJT) is:

A. Voltage-controlled via a gate

B. A two-terminal passive device

C. Used only as a rectifier

D. Current-controlled via the base

39. The quiescent point of an amplifier is set by its:

A. DC biasing conditions

B. Peak AC signal level

C. Load resistance alone

D. Input frequency

40. An ideal op-amp golden rule states that the current into its inputs is:

A. Equal to the output current

B. Zero, from infinite impedance

C. Half the feedback current

D. Maximum at all times

41. A rectifier is a power-electronic circuit that converts:

A. DC into AC

B. DC into higher DC

C. AC into higher AC

D. AC into DC

42. An instrumentation amplifier's key strength is its high:

A. Common-mode rejection of noise

B. Output current for motors

C. Switching frequency

D. Power dissipation

43. Real power in an AC circuit is the component:

A. Oscillating without consumption

B. Actually consumed as useful work

C. Equal always to apparent power

D. Measured only in VAR

44. The power triangle relates apparent power S to P and Q by:

A. $S = P + Q$ added directly

B. $S = P - Q$ subtracted

C. $S = P \times Q$ multiplied

D. $S^2 = P^2 + Q^2$

45. A load draws real power 800 W and apparent power 1000 VA. Its power factor is:

A. 1.25

B. 0.20

C. 1.00

D. 0.80

46. In a balanced wye three-phase connection, the line voltage equals the phase voltage times:

A. 3 exactly

B. $1/\sqrt{3}$

C. $\sqrt{3}$ (about 1.732)

D. 2 exactly

47. Power is transmitted at high voltage primarily to:

A. Increase the line current

B. Eliminate transformers

C. Raise the supply frequency

D. Minimize $I^2R$ losses

48. An ideal transformer's primary-to-secondary voltage ratio equals:

A. The inverse turns ratio

B. The square of the turns ratio

C. Unity for all transformers

D. The turns ratio Np/Ns

49. A transformer operates only on AC because its operation requires a:

A. Continuously changing magnetic flux

B. Perfectly steady DC current

C. Zero net magnetic field

D. Direct connection between windings

50. In an induction motor, the difference between synchronous speed and rotor speed is called:

A. The commutation angle

B. The power factor

C. Slip

D. Torque ripple

51. Faraday's law states that a voltage is induced by a changing:

A. Electric charge density

B. Resistance value

C. Magnetic flux

D. Ambient temperature

52. Coulomb's law describes the force between two charges as varying with distance as the:

A. Direct first power

B. Inverse square

C. Cube of distance

D. Constant value

53. A conductor whose length is comparable to the signal wavelength must be modeled as a:

A. Lumped resistor

B. Transmission line

C. Pure capacitor

D. DC short circuit

54. Maxwell's equations predict that electromagnetic waves in free space travel at:

A. The speed of light

B. The speed of sound

C. A frequency-dependent speed

D. An infinite speed

55. A closed-loop control system differs from open-loop in that it:

A. Applies control without measuring output

B. Cannot reject any disturbance

C. Measures the output and feeds it back

D. Works only at one frequency

56. A negative-feedback system with forward gain G and feedback gain H has a closed-loop transfer function of:

A. $G \times (1 + GH)$

B. $G / (1 + GH)$

C. (1 + GH) / G

D. GH / (1 − G)

57. A continuous linear system is stable if all its poles lie in the:

A. Right half-plane

B. Left half-plane

C. Upper half-plane only

D. Exactly on the axis

58. A Bode plot displays a system's response as:

A. Magnitude and phase versus frequency

B. Voltage versus current

C. Power versus resistance

D. Input versus output amplitude

59. Modulation shifts an information signal onto a carrier mainly to:

A. Reduce the signal's information content

B. Enable practical high-frequency transmission

C. Increase receiver power consumption

D. Remove all channel noise

60. Amplitude modulation varies the carrier's:

A. Frequency

B. Phase

C. Amplitude

D. Wavelength only

61. A Fourier series decomposes a periodic signal into:

A. A continuous frequency band

B. Random noise components

C. A fundamental and its harmonics

D. A single DC term

62. Time Division Multiplexing shares a channel by assigning each signal a distinct:

A. Time slot

B. Frequency band

C. Spreading code

D. Physical wire

63. The Shannon-Hartley theorem relates channel capacity to bandwidth and the:

A. Cable length

B. Number of users

C. Carrier frequency alone

D. Signal-to-noise ratio

64. Convert binary 10110 to decimal:

A. 18

B. 20

C. 22

D. 26

65. De Morgan's theorem converts NOT(A AND B) into:

A. (NOT A) OR (NOT B)

B. (NOT A) AND (NOT B)

C. A OR B directly

D. A AND B unchanged

66. A NAND gate is functionally complete, meaning:

A. Any logic function can be built from it

B. It consumes the least power

C. It operates faster than all gates

D. It needs no power supply

67. A D flip-flop captures its input value:

A. Continuously at all times

B. Only at power-up

C. At the active clock edge

D. At random intervals

68. A 4-bit binary counter cycles through how many distinct states?

A. 16

B. 8

C. 4

D. 32

69. A finite state machine is most commonly represented by a:

A. State diagram

B. Power triangle

C. Bode plot

D. Cash-flow diagram

70. An FPGA is valued because its logic can be:

A. Fixed permanently at manufacture

B. Limited to a single function

C. Reconfigured after manufacture

D. Operated with no configuration

71. In a star network topology, the central hub is a:

A. Source of full redundancy

B. Backup for every node

C. Means of zero downtime

D. Single point of failure

72. The OSI model defines how many layers?

A. Four

B. Five

C. Seven

D. Ten

73. In the CIA triad, keeping data secret from unauthorized parties is:

A. Integrity

B. Availability

C. Confidentiality

D. Redundancy

74. An intrusion prevention system (IPS) differs from a detection system in that it:

A. Only logs events silently

B. Operates with no rules

C. Monitors but never acts

D. Actively blocks detected threats

75. The fetch-decode-execute cycle is the basic operation of the:

A. Power supply unit

B. Network router

C. Cooling system

D. Processor (CPU)

76. In the memory hierarchy, registers are:

A. The largest, slowest memory

B. Non-volatile permanent storage

C. The fastest, smallest memory

D. Cheaper per bit than disk

77. RAM is volatile memory, meaning it:

A. Retains data without power

B. Stores boot firmware permanently

C. Can only be read, never written

D. Loses contents when powered off

78. Direct Memory Access improves efficiency by transferring data:

A. One bit at a time via the CPU

B. Only after each interrupt

C. Exclusively to read-only memory

D. Without CPU involvement per item

79. An algorithm with O(1) complexity has a running time that:

A. Does not change with input size

B. Grows linearly with input

C. Grows with the square of input

D. Grows logarithmically

80. A data structure following Last-In-First-Out order is a:

A. Queue

B. Stack

C. Binary tree

D. Hash table

81. A recursive function without a reachable base case will:

A. Cause a stack overflow

B. Produce a correct result

C. Use less memory

D. Run faster overall

82. The three control-flow structures of structured programming are sequence, selection, and:

A. Recursion

B. Compilation

C. Iteration

D. Encryption

83. Convert hexadecimal 0x2A to decimal:

A. 26

B. 32

C. 42

D. 52

84. An XOR gate outputs logic 1 when its two inputs are:

A. Both logic 1

B. Different from each other

C. Both logic 0

D. Always regardless

85. A binary search on 1024 sorted elements requires at most about how many comparisons?

A. 1024

B. 10

C. 512

D. 32

86. A balanced three-phase delta source has phase current 15 A. The line current is approximately:

A. 15 A

B. 8.7 A

C. 26 A

D. 45 A

87. A 12-bit address bus can directly address how many memory locations?

A. 12

B. 4,096

C. 256

D. 1,024

88. An ideal transformer with 300 primary turns and 60 secondary turns has a turns ratio (primary:secondary) of:

A. 1:5

B. 5:1

C. 1:1

D. 2:1

89. A signal of very short duration occupies a frequency spectrum that is:

A. Wide in bandwidth

B. A single frequency only

C. Confined to zero frequency

D. Equally narrow

90. A capacitor's reactance at very low frequency approaches:

A. A very large value, blocking the signal

B. Zero, passing the signal

C. The resistance value

D. A fixed negative constant

91. A 6 Ω and a 3 Ω resistor in parallel give an equivalent resistance of:

A. 9 Ω

B. 2 Ω

C. 4.5 Ω

D. 18 Ω

92. An ideal op-amp has an input impedance modeled as:

A. Infinite

B. Zero ohms

C. A low fixed value

D. Negative

93. A magnetic field circles a current-carrying wire; its direction is found using the:

A. Coulomb inverse-square law

B. Ohmic voltage rule

C. Superposition principle

D. Right-hand rule

94. A common-emitter amplifier's main advantage is that it provides:

A. Unity gain for buffering

B. Substantial voltage and current gain

C. No phase change at the output

D. Direct AC rectification

95. Two mutually exclusive events have probabilities 0.3 and 0.2. The probability of either occurring is:

A. 0.06

B. 0.10

C. 0.25

D. 0.50

96. A transformer's reflected impedance at the primary scales with the turns ratio by:

A. The turns ratio directly

B. The inverse turns ratio

C. The square of the turns ratio

D. Unity in all cases

97. A control system is stable but settles slowly with large steady-state error. This shows that stability:

A. Guarantees fast response

B. Requires right half-plane poles

C. Eliminates all error

D. Does not by itself ensure good performance

98. Parallel impedances in an AC circuit combine using:

A. Reciprocals, like parallel resistors

B. Direct addition of values

C. Subtraction of magnitudes

D. Multiplication of angles

99. A material with a moderate, controllable band gap is classified as a:

A. Conductor

B. Insulator

C. Semiconductor

D. Superconductor

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

A. Mean

B. Median

C. Range

D. Variance

101. An RC circuit with R = 5 kΩ and C = 4 μF has a time constant of:

A. 1.25 ms

B. 9 ms

C. 20 ms

D. 200 ms

102. A diode conducts when its anode is positive relative to its cathode. This is called:

A. Reverse breakdown

B. Forward bias

C. Cutoff operation

D. Saturation blocking

103. An inverter converts:

A. AC into DC

B. DC into a lower DC

C. DC into AC

D. AC into higher AC

104. A three-phase wye load draws 8 A line current at 208 V line voltage with unity power factor. The total real power is approximately:

A. 1,664 W

B. 960 W

C. 2,880 W

D. 4,320 W

105. An engineer declines a project outside their specialty. The governing ethical duty is to:

A. Practice only within one's competence

B. Maximize billable hours

C. Conceal any limitation

D. Accept all assignments

106. The current through a capacitor is proportional to the rate of change of:

A. The voltage across it

B. The magnetic flux

C. The current itself

D. The resistance

107. A processor responds to an external event by suspending its task to run a routine. The trigger is a(n):

A. Cache miss

B. Clock divide

C. Interrupt

D. DMA burst

108. An engineer compares two machines with different service lives. The cleanest method is:

A. Present worth without horizon match

B. Simple payback ignoring interest

C. Counting replaced parts

D. Equivalent annual cost analysis

109. Convert binary 11001 to decimal:

A. 19

B. 23

C. 25

D. 50

110. A logic gate outputs 0 only when both inputs are 1; otherwise it outputs 1. This is a:

A. AND gate

B. NAND gate

C. OR gate

D. XOR gate

## Answer Key & Full Explanations

1. B — By the power rule, $d/dx(5x^3) = 3 \cdot 5x^2 = 15x^2$. The exponent multiplies the coefficient and decreases by one. This rule underlies all rate-of-change problems.

2. D — Rectangular components are $r \cdot \cos\theta$ and $r \cdot \sin\theta$: $10 \cdot \cos 53.13° \approx 6$ and $10 \cdot \sin 53.13° \approx 8$, giving $6 + j8$. This is the classic 3-4-5 scaled triangle. Polar-to-rectangular conversion is essential for impedance work.

3. C — The integral of $6x$ is $6 \cdot (x^2/2) + C = 3x^2 + C$. Raise the power and divide by the new exponent. Always include the constant of integration.

4. D — A zero dot product means the vectors are perpendicular, since the dot product is $|A||B|\cos\theta$ and $\cos 90° = 0$. This is the definitive orthogonality test. It appears in projection and field problems.

5. D — Two distinct negative real roots produce an overdamped response that returns to steady state slowly without oscillating. Complex roots would give oscillation and a repeated root critical damping. Root type determines transient behavior.

6. B — The mean is the sum divided by the count: $(5 + 10 + 10 + 15 + 20)/5 = 60/5 = 12$. The mean is the arithmetic average. It is sensitive to every value.

7. A — The empirical rule gives approximately 68% of values within one standard deviation of the mean. Within two it is 95% and within three 99.7%. These figures allow quick probability estimates.

8. D — Expected value is the probability-weighted average: $(0.4)(\$1{,}500) + (0.6)(\$0) = \$600$. Each outcome is weighted by its probability and summed. This underlies economic risk analysis.

9. B — Compound growth: $F = P(1 + i)^n = 2000(1.10)^1 = \$2{,}200$. Interest is applied to the principal over one year. Compounding is the FE default.

10. D — A benefit-cost ratio below 1.0 (here 0.75) means costs exceed benefits, so the project is not justified. Only a ratio above 1.0 justifies a project. The threshold is the decision rule.

11. A — Disclosing a financial interest in a bidding firm stems from the duty to act as a faithful agent, free of undisclosed conflicts. Engineers must disclose and manage conflicts. This preserves impartiality and trust.

12. A — A utility patent typically grants exclusive rights for about 20 years from filing, after which the invention enters the public domain. This limited term is the trade-off for public disclosure. Patents differ from indefinite trade secrets.

13. C — An engineer may seal documents only if the work was prepared by them or under their direct supervision. Sealing unsupervised work is a serious violation. This rule preserves accountability.

14. C — Acceptor doping creates holes, which act as positive charge carriers, making the material P-type. Donor doping adds free electrons instead. Carrier type governs junction behavior.

15. B — Permittivity governs a capacitor's ability to store charge, since capacitance depends directly on the dielectric's permittivity. Higher permittivity yields greater capacitance. This is why dielectric choice matters.

16. A — Heating a silicon semiconductor decreases its resistance, because added thermal energy promotes more electrons across the band gap. Conductors behave oppositely. This contrast is a common exam point.

17. B — Under forward bias, the barrier is reduced and the depletion region narrows, allowing current to flow. Reverse bias widens it and blocks current. This one-way behavior is the basis of rectification.

18. B — Kirchhoff's Voltage Law expresses conservation of energy: the sum of voltages around a closed loop is zero. KCL, by contrast, conserves charge at a node. KVL is the basis of mesh analysis.

19. A — Equal parallel resistors combine to the value divided by the count: $9/3 = 3\ \Omega$. Parallel resistance is always less than the smallest branch. An answer above $9\ \Omega$ would signal an error.

20. D — An ideal current source is deactivated by replacing it with an open circuit when finding Thevenin resistance. A voltage source becomes a short. Correct deactivation is essential.

21. B — RMS equals peak divided by $\sqrt{2}$: $100/1.414 \approx 70.7$ V. RMS is the equivalent DC value delivering the same power. Power calculations always use RMS.

22. B — A capacitor's impedance is $1/(j\omega C)$, a negative imaginary quantity that decreases with frequency. An inductor's is $j\omega L$ and a resistor's is real. These impedances enable AC circuit algebra.

23. D — Nodal analysis applies KCL at each node to solve for node voltages relative to a chosen reference. It is efficient when a circuit has few nodes. The equations are then solved simultaneously.

24. D — Capacitive reactance is $1/(\omega C)$, which decreases as frequency rises, so capacitors increasingly pass high frequencies. Inductive reactance does the opposite. This behavior underlies capacitor-based filtering.

25. C — The "ELI" portion of the mnemonic indicates that in an inductor (L), voltage (E) leads current (I) by 90°. A capacitor does the opposite. This mnemonic recalls reactive phase relationships.

26. A — The total response of a linear system equals the transient (natural) response plus the steady-state (forced) response. The transient decays while the steady-state persists. This maps to homogeneous and particular ODE solutions.

27. C — At series resonance, inductive and capacitive reactances cancel, leaving minimum, purely resistive impedance and maximum current. A parallel resonant circuit behaves oppositely. The reactances offset at the resonant frequency.

28. C — A high quality factor Q indicates a narrow, sharp resonant response. Q is inversely related to bandwidth. High-Q circuits provide selective tuning.

29. D — The Laplace transform converts time-domain differentiation into multiplication by s, turning differential equations into algebraic ones. Integration becomes division by s. This is why it is indispensable for transient analysis.

30. A — Zeros are the values of s that make a transfer function's numerator zero, driving the response toward zero. Poles are the denominator roots. Their locations shape the frequency response.

31. A — The Nyquist theorem requires sampling at least twice the highest signal frequency to allow faithful reconstruction. Sampling slower causes irreversible aliasing. The factor of two is the key threshold.

32. B — Aliasing results from sampling below the Nyquist rate, causing high frequencies to masquerade as lower ones. The distortion is irreversible. Adequate sampling or anti-aliasing filtering prevents it.

33. B — A low-pass filter passes low frequencies and attenuates high ones. A high-pass filter does the reverse. Frequency-dependent reactance makes this selective behavior possible.

34. A — The cutoff frequency is where output power falls to half its passband value, the −3 dB point. Voltage gain there is about 0.707 of maximum. This defines the passband edge.

35. D — A digital filter operating on sampled data is analyzed using the Z-transform, the discrete-time analog of the Laplace transform. Difference equations replace differential equations. This analogy transfers analog intuition to digital systems.

36. D — A conducting silicon diode is modeled with a constant 0.7 V forward drop for exam analysis. This is accurate enough and far faster than the exponential equation. The ideal model assumes zero drop instead.

37. B — A Zener diode is designed to operate in reverse breakdown at a precise voltage, useful for regulation. Standard diodes conduct in forward bias. This controlled breakdown is its defining feature.

38. D — A BJT is current-controlled: a small base current controls a much larger collector current. A FET is voltage-controlled via its gate instead. This control mechanism distinguishes the transistor families.

39. A — The quiescent point is set by the DC biasing conditions, establishing where the transistor operates with no signal applied. A well-chosen Q-point keeps it in the active region. AC signals ride on this DC point.

40. B — One op-amp golden rule is that the current into the inputs is zero, owing to infinite input impedance. The second is equal input voltages under negative feedback. Together they solve op-amp circuits.

41. D — A rectifier converts AC into DC by exploiting diode one-way conduction. An inverter does the opposite. Matching the device to its conversion direction gives the answer.

42. A — An instrumentation amplifier's key strength is high common-mode rejection, letting it amplify a small differential signal while rejecting noise common to both inputs. This makes it ideal for sensor signals. It also has high input impedance.

43. B — Real power is the component actually consumed and converted to useful work or heat, measured in watts. Reactive power oscillates without consumption. Only resistance consumes real power.

44. D — The power triangle relates the three powers as $S^2 = P^2 + Q^2$, with apparent power as the hypotenuse. The angle between P and S is the phase angle. This anchors AC power calculations.

45. D — Power factor is real divided by apparent power: 800/1000 = 0.80. It equals the cosine of the phase angle. A value below 1.0 indicates reactive loading.

46. C — In a wye connection, line voltage is $\sqrt{3}$ times phase voltage. The $\sqrt{3}$ factor is the signature of three-phase systems. In delta, the $\sqrt{3}$ applies to current instead.

47. D — High transmission voltage reduces current for fixed power, and since losses are $I^2R$, lower current sharply cuts losses. This is the rationale for high-voltage transmission. Transformers enable the voltage changes.

48. D — In an ideal transformer, the primary-to-secondary voltage ratio equals the turns ratio Np/Ns, while the current ratio is its inverse. A step-up transformer raises voltage and lowers current. Power in approximately equals power out.

49. A — A transformer requires a continuously changing magnetic flux to induce a secondary voltage, which only AC provides. Steady DC produces no changing flux. This is why transformers are AC-only.

50. C — Slip is the difference between synchronous speed and the actual rotor speed of an induction motor. Slip is essential because it enables rotor current and torque. At synchronous speed no torque would develop.

51. C — Faraday's law states that a voltage is induced by a changing magnetic flux. A static field induces nothing. This principle underlies transformers, generators, and inductors.

52. B — Coulomb's law states the force between two charges varies as the inverse square of the distance. Doubling the distance quarters the force. This inverse-square dependence defines the electric field.

53. B — When a conductor's length is comparable to the signal wavelength, transmission-line effects dominate and it must be modeled as a transmission line. At low frequencies a short wire needs no such treatment. Recognizing this regime is the key judgment.

54. A — Maxwell's equations predict that electromagnetic waves travel at the speed of light in free space, independent of frequency. This unifies radio, light, and wireless signals. The constancy of this speed is foundational.

55. C — A closed-loop system measures its output and feeds it back to compare against the desired value, enabling self-correction. An open-loop system does not. Feedback gives control systems their accuracy.

56. B — For negative feedback with forward gain G and feedback gain H, the closed-loop transfer function is G/(1 + GH). Reducing a block diagram to its forward and feedback paths lets you apply this. It answers many control questions.

57. B — A continuous linear system is stable if all its poles lie in the left half-plane (negative real parts). A single right-half-plane pole causes instability. This pole criterion is the bedrock of stability analysis.

58. A — A Bode plot displays magnitude (in dB) and phase (in degrees) versus frequency on logarithmic axes. It reveals stability margins. These plots are a standard control-analysis tool.

59. B — Modulation shifts an information signal onto a high-frequency carrier to enable practical transmission, since antennas of reasonable size require high frequencies. It also lets signals share the spectrum. This need explains all radio communication.

60. C — Amplitude modulation varies the carrier's amplitude in proportion to the message, while frequency stays constant. FM and PM vary frequency and phase instead. AM's amplitude dependence makes it noise-susceptible.

61. C — A Fourier series decomposes a periodic signal into a fundamental and its harmonics, producing a discrete spectrum. The Fourier transform handles non-periodic signals. Both reveal frequency content.

62. A — Time Division Multiplexing assigns each signal a distinct time slot, with all using the full bandwidth in turn. FDM divides frequency and CDM uses codes. The shared dimension identifies the technique.

63. D — The Shannon-Hartley theorem relates channel capacity to bandwidth and the signal-to-noise ratio. Raising either increases capacity. This sets the ceiling on reliable transmission.

64. C — Binary 10110 equals 16 + 0 + 4 + 2 + 0 = 22 in decimal. Summing the set bits' place values gives the value. Base conversion is a routine skill.

65. A — De Morgan's theorem gives NOT(A AND B) = (NOT A) OR (NOT B). It converts an AND complement into an OR of complements. This identity is central to logic simplification.

66. A — A NAND gate is functionally complete, meaning any logic function can be built from it alone. NOR shares this property. This universality makes NAND fundamental in integrated circuits.

67. C — A D flip-flop captures its input value at the active clock edge and holds it until the next edge. Edge triggering synchronizes state changes. This makes digital systems reliable.

68. A — A 4-bit counter cycles through $2^4 = 16$ distinct states before repeating. The number of states equals two raised to the bit count. Counters step through these with each clock pulse.

69. A — A finite state machine is most commonly represented by a state diagram, with states as nodes and transitions as labeled arrows. Tracing it by inputs reveals its behavior. It is the standard FSM design tool.

70. C — An FPGA's value is that its logic can be reconfigured after manufacture to implement different designs. Fixed-function chips cannot. Reconfigurability is the FPGA's defining advantage.

71. D — In a star topology, the central hub is a single point of failure; its failure disables the whole network. The star is easy to manage but carries this vulnerability. Each topology has a defining trade-off.

72. C — The OSI model defines seven layers, from Physical up to Application. The TCP/IP model condenses these into four. Layering isolates functions so each can be designed independently.

73. C — Keeping data secret from unauthorized parties is Confidentiality in the CIA triad. Integrity concerns alteration and Availability concerns access. Each security goal maps to one pillar.

74. D — An intrusion prevention system actively blocks detected threats, while a detection system only monitors and alerts. The distinction is action versus observation. An IPS protects in real time.

75. D — The fetch-decode-execute cycle is the basic operation of the processor (CPU), repeating continuously and paced by the clock. Registers, the ALU, and the control unit carry it out. It is the rhythm of computation.

76. C — Registers are the fastest but smallest memory in the hierarchy, holding immediate working values. Cache, main memory, and disk grow larger but slower. This speed-versus-capacity trade-off is central to performance.

77. D — RAM is volatile, losing its contents when power is removed. ROM and flash are non-volatile. This distinction determines what survives a power cycle.

78. D — Direct Memory Access transfers data between a peripheral and memory without CPU involvement per item, freeing the processor. It is the most efficient method for large transfers. The CPU sets up the transfer and is then offloaded.

79. A — O(1) complexity means the running time does not change with input size. Doubling the input leaves the time unchanged. This is the most efficient scaling class.

80. B — A stack follows Last-In-First-Out order: the most recently added item is removed first. A queue is FIFO instead. Stacks model nested or reversible processes such as function calls.

81. A — A recursive function without a reachable base case calls itself indefinitely, exhausting the stack and causing a stack overflow. The base case must be reachable. Identifying it first is essential.

82. C — The three control-flow structures of structured programming are sequence, selection, and iteration (loops). Together they express any computation. Recognizing them is key to tracing program logic.

83. C — Hex 0x2A equals $2 \times 16 + 10 = 42$ in decimal, where A is 10. Each hex digit is weighted by a power of 16. Hex-to-decimal conversion is a routine skill.

84. B — An XOR gate outputs 1 only when its two inputs are different from each other. When they match, it outputs 0. This difference-detecting behavior is used in adders and parity circuits.

85. B — Binary search halves the range each step, so 1024 elements require at most $\log_2(1024) = 10$ comparisons. This O(log n) efficiency requires sorted data. Repeated halving makes the search fast.

86. C — In a delta connection, line current is $\sqrt{3}$ times phase current: $15 \times 1.732 \approx 26$ A. The $\sqrt{3}$ factor applies to current in delta connections. Anchoring it to the connection type prevents errors.

87. B — A 12-bit address bus addresses $2^{12} = 4{,}096$ distinct locations. The address bus width sets the maximum addressable memory. Each added line doubles the reach.

88. B — The turns ratio is primary:secondary = 300:60 = 5:1. More primary turns than secondary means this is a step-down configuration. The voltage ratio equals this turns ratio.

89. A — By the inverse time-frequency relationship, a signal of very short duration occupies a wide bandwidth. Brief pulses demand more spectrum. This trade-off ultimately limits data rates.

90. A — A capacitor's reactance is $1/(\omega C)$, which becomes very large at low frequency, blocking the signal. At high frequency it approaches zero. This frequency dependence underlies filtering.

91. B — Parallel combination: $(6 \times 3)/(6 + 3) = 18/9 = 2\ \Omega$. Parallel resistance is always less than the smallest branch. An answer above 3 Ω would signal an error.

92. A — An ideal op-amp has infinite input impedance, so it draws no current and does not load the source. This is one of the two golden rules. It allows clean KCL analysis at the inputs.

93. D — The direction of the magnetic field circling a current-carrying wire is found with the right-hand rule. Coulomb's and Ohm's laws do not apply here. This rule resolves magnetostatics direction questions.

94. B — The common-emitter amplifier provides substantial voltage and current gain, making it the general-purpose workhorse. The emitter follower buffers with near-unity voltage gain instead. Configurations are identified by their gain signatures.

95. D — For mutually exclusive events, the probability of either is the sum: $0.3 + 0.2 = 0.5$. No overlap term is subtracted because they cannot occur together. Recognizing mutual exclusivity sets the rule.

96. C — A transformer's reflected impedance at the primary scales with the square of the turns ratio. This lets transformers perform impedance matching. The squared relationship is a tested exam point.

97. D — A stable system that settles slowly with large steady-state error shows that stability does not by itself ensure good performance. Stability is a yes/no pole condition; performance is a matter of degree. The exam tests both separately.

98. A — Parallel impedances combine using reciprocals, just as parallel resistors do, but with complex arithmetic. Series impedances add directly instead. Once components are impedances, DC rules apply with complex numbers.

99. C — A material with a moderate, controllable band gap is a semiconductor. Conductors have negligible gaps and insulators large ones. This controllability is the basis of solid-state electronics.

100. D — The standard deviation is the square root of the variance, returning the measure to the original units of the data. Variance is in squared units. Standard deviation is the most informative spread measure.

101. C — The time constant is $\tau = RC = 5000 \times 4 \times 10^{-6} = 0.02$ s = 20 ms. After one time constant the response completes about 63% of its change. This governs RC transients.

102. B — A diode conducts when its anode is positive relative to its cathode, the condition called forward bias. Reverse bias blocks current. This one-way behavior is the basis of rectification.

103. C — An inverter converts DC into AC, the inverse of a rectifier. DC-DC converters change DC levels instead. Matching the device to its conversion direction gives the answer.

104. C — Three-phase real power is $P = \sqrt{3} \times V_{line} \times I_{line} \times \cos\theta = 1.732 \times 208 \times 8 \times 1.0 \approx 2{,}880$ W. The $\sqrt{3}$ factor is the signature of three-phase calculations. Unity power factor means all apparent power is real.

105. A — Declining a project outside one's specialty reflects the duty to practice only within one's area of competence. Accepting it to maximize billable hours would violate that duty. Competence protects public safety.

106. A — The current through a capacitor is proportional to the rate of change of the voltage across it ($i = C\,dv/dt$). A constant voltage produces no current. This relationship defines capacitor behavior.

107. C — A signal that suspends the processor's task to run a routine is an interrupt. It lets the processor respond promptly without continuous polling. The processor resumes its task afterward.

108. D — Comparing machines with different service lives is cleanest with equivalent annual cost analysis, which places everything on a per-year basis. Present worth would require equalizing horizons. Annual cost handles unequal lives directly.

109. C — Binary 11001 equals 16 + 8 + 0 + 0 + 1 = 25 in decimal. Summing the set bits' place values gives the value. Base conversion is a routine skill.

110. B — A gate whose output is 0 only when both inputs are 1, and 1 otherwise, is a NAND gate (the complement of AND). NAND is functionally complete. It is common in integrated circuits.