

PRACTICE EXAM 7 (110 QUESTIONS)

1. A technician computes the rate at which a changing capacitor voltage produces current and recalls that current depends on the derivative of voltage. For $v(t) = 4t^2$, the derivative dv/dt is:

- A. $8t$
- B. $4t$
- C. $2t^2$
- D. $8t^2$

2. An engineer measures an impedance as $3 + j4$ ohms and needs its magnitude for a calculation. The magnitude is:

- A. 3.0Ω
- B. 5.0Ω
- C. 7.0Ω
- D. 12.0Ω

3. A student must verify a trig identity used in a phasor proof. Which identity holds for every angle?

- A. $\sin \theta + \cos \theta = 1$
- B. $\tan \theta = \cos \theta / \sin \theta$
- C. $\sin^2 \theta + \cos^2 \theta = 1$
- D. $\sin 2\theta = 2 \sin \theta$

4. An engineer sets up three node equations and solves them as a matrix. The matrix approach is preferred over substitution because it is:

- A. Always less accurate
- B. Limited to two equations
- C. Faster and less error-prone
- D. Only valid for AC circuits

5. A circuit's transient completes about 63% of its change in one interval. That interval is the:

- A. Resonant period
- B. Time constant
- C. Settling time
- D. Rise time only

6. An engineer needs a vector perpendicular to two given vectors to find a magnetic force direction. The operation that yields it is the:

- A. Cross product
- B. Dot product
- C. Scalar sum
- D. Magnitude ratio

7. A reliability analyst models the number of equipment failures in a fixed time interval. The appropriate distribution is the:

- A. Poisson distribution
- B. Uniform distribution only
- C. Sinusoidal distribution
- D. Linear distribution

8. A quality engineer finds the average of squared deviations from the mean. This quantity is the:

- A. Mode of the data
- B. Median value
- C. Range of values
- D. Variance

9. A project yields \$1,000 with probability 0.8 and \$0 with probability 0.2. For budgeting, the expected value used is:

- A. \$1,000
- B. \$200
- C. \$500
- D. \$800

10. An accountant needs the future value of \$1,000 invested at 5% for one year. It grows to:

- A. \$950
- B. \$1,005
- C. \$1,050
- D. \$1,500

11. A plant manager evaluates a project with a benefit-cost ratio of 1.6 and concludes the project's benefits:

- A. Fall short of its costs
- B. Exceed its costs and justify it
- C. Equal its costs exactly
- D. Cannot be determined

12. An engineer is offered consulting fees by a supplier whose equipment they are evaluating. The first ethical step is to:

- A. Accept the fees discreetly
- B. Evaluate the equipment first
- C. Disclose the conflict of interest
- D. Reject all future work permanently

13. A software developer wants protection for their original source code. The most fitting intellectual property type is:

- A. Copyright
- B. A patent
- C. A trademark
- D. A trade secret

14. A licensed engineer is asked to stamp drawings they did not supervise. The correct response, per the Model Rules, is to:

- A. Stamp them to assist the firm
- B. Refuse to seal unsupervised work
- C. Stamp after a brief glance
- D. Delegate the stamping to staff

15. A semiconductor sample is doped to add free electrons as majority carriers. The result is:

- A. P-type material
- B. An intrinsic crystal
- C. N-type material

D. An insulating layer

16. A technician heats a copper busbar and monitors its resistance. The expected observation is that resistance:

A. Increases with temperature

B. Decreases with temperature

C. Stays exactly constant

D. Falls abruptly to zero

17. An engineer selects a dielectric to increase a capacitor's capacitance. The property to maximize is the material's:

A. Magnetic permeability

B. Electric permittivity

C. Thermal conductivity

D. Mechanical hardness

18. A diode in a circuit is reverse biased. A technician measuring the current expects to find it:

A. Large and rising with voltage

B. Equal to forward current

C. Essentially zero

D. Oscillating at line frequency

19. A designer needs the equivalent of two $8\ \Omega$ resistors in parallel. The result is:

A. $16\ \Omega$

B. $8\ \Omega$

C. 4Ω

D. 2Ω

20. An engineer reduces a complex two-terminal network to a single voltage source and series resistance. This is the:

A. Thevenin equivalent

B. Norton current source

C. Superposition sum

D. Resonant model

21. A technician observes that in one element, current lags the voltage by 90° . The element is a(n):

A. Resistor

B. Capacitor

C. Ideal source

D. Inductor

22. An engineer must compute power delivered to a resistor by a 100 V peak sinusoid. The voltage value used is:

A. 100 V peak

B. 141 V

C. 50 V

D. 70.7 V RMS

23. A technician notes that at one frequency a series RLC circuit draws maximum current. At that frequency the circuit is:

- A. At resonance
- B. Open circuited
- C. Purely capacitive
- D. In cutoff

24. An engineer applies the Laplace transform to a circuit's differential equation. The benefit is that calculus becomes:

- A. Trigonometry
- B. Algebra
- C. Geometry
- D. Statistics

25. A signal contains frequencies up to 10 kHz. To avoid aliasing, the engineer samples at no less than:

- A. 10 kHz
- B. 20 kHz
- C. 5 kHz
- D. 2 kHz

26. A technician needs a circuit that passes a 50 Hz signal but blocks a 20 kHz interference. The required filter is a:

- A. Low-pass filter
- B. High-pass filter
- C. All-pass filter
- D. Pure differentiator

27. An analyst finds a transfer function denominator root at $s = -5$. This root is a:

- A. Zero of the system
- B. Pole of the system
- C. Gain margin
- D. Phase crossover

28. A designer needs a resonant filter that selects a very narrow frequency band. This calls for a circuit with a:

- A. Low quality factor
- B. Broad bandwidth
- C. High quality factor
- D. Purely resistive load

29. A technician models a conducting silicon diode for hand calculations. The forward voltage drop assumed is:

- A. 0.0 V
- B. 0.7 V
- C. 5.0 V
- D. 12.0 V

30. An engineer needs an amplifier stage to buffer a source from a low-impedance load without voltage gain. The choice is a:

- A. Common-emitter stage
- B. Tuned amplifier
- C. Class-C switcher

D. Voltage follower

31. A technician analyzing an op-amp circuit applies the rule that no current enters the inputs. This follows from the op-amp's:

- A. Zero output impedance
- B. Negative supply rail
- C. Infinite input impedance
- D. Finite open-loop gain

32. An engineer needs to convert a battery's DC into AC for an appliance. The required power-electronic device is a(n):

- A. Rectifier
- B. Linear regulator
- C. Inverter
- D. Forward diode

33. A transistor used for digital switching toggles between which two regions?

- A. Cutoff and saturation
- B. Active and breakdown
- C. Active only
- D. Reverse and forward bias

34. A technician must amplify a tiny thermocouple signal while rejecting noise common to both leads. The device for this is an:

- A. Half-wave rectifier

- B. Passive RC filter
- C. Simple common-base stage
- D. Instrumentation amplifier

35. An engineer measures real power 600 W and reactive power 800 VAR. The apparent power is:

- A. 1000 VA
- B. 1400 VA
- C. 200 VA
- D. 700 VA

36. A technician reads a power factor of 0.7 lagging on a motor and proposes correction using:

- A. Capacitors to supply reactive power
- B. Additional inductive load
- C. More series resistance
- D. A second identical motor

37. A wye-connected source has a phase voltage of 120 V. The technician measures a line voltage of approximately:

- A. 120 V
- B. 60 V
- C. 208 V
- D. 360 V

38. A utility transmits power at high voltage to reduce, for fixed power, the:

- A. Current and I^2R losses
- B. Supply frequency
- C. Voltage at the load
- D. Transformer count

39. A transformer has 100 primary and 400 secondary turns at 120 V primary. The secondary voltage is:

- A. 30 V
- B. 120 V
- C. 240 V
- D. 480 V

40. A technician observes a motor running at constant speed regardless of load. The motor is most likely:

- A. An induction motor
- B. A DC series motor
- C. A synchronous motor
- D. A universal motor

41. A technician measures a voltage induced in a coil only when the magnetic flux through it changes. This is explained by:

- A. Faraday's law
- B. Ohm's law
- C. Coulomb's law
- D. Gauss's law for magnetism

42. An engineer notes the force between two charges quadruples when their distance is halved. This is consistent with:

- A. The inverse-square law
- B. A linear distance law
- C. A cube-law dependence
- D. Distance independence

43. A high-frequency signal travels down a cable whose length is comparable to its wavelength. The cable must be treated as a:

- A. Lumped capacitor
- B. Transmission line
- C. Pure resistor
- D. DC short

44. A technician finds a load matched to a line so there are no reflections. The load impedance equals the line's:

- A. Total length
- B. Source voltage
- C. Operating frequency
- D. Characteristic impedance

45. An engineer designs a system that measures its output and adjusts to reduce error automatically. This is a:

- A. Manual override system
- B. Pure feedforward path
- C. Single open-loop chain

D. Closed-loop feedback system

46. A control system has forward gain 19 and unity feedback. Its closed-loop gain is approximately:

- A. 19
- B. 0.95
- C. 20
- D. 1.0

47. A technician finds all closed-loop poles in the left half-plane and concludes the system is:

- A. Stable
- B. Unstable
- C. Marginal only
- D. Oscillating without bound

48. An engineer reads gain and phase versus frequency from a single graph to assess stability margins. The graph is a:

- A. Bode plot
- B. Smith chart only
- C. Cash-flow diagram
- D. Karnaugh map

49. A radio engineer shifts a 2 kHz audio signal onto an 800 MHz carrier for transmission. This process is:

- A. Quantization

- B. Modulation
- C. Multiplexing
- D. Rectification

50. A technician chooses FM over AM for a noisy link, accepting wider bandwidth, because FM is:

- A. Lower in cost always
- B. Free of any carrier
- C. Narrower in bandwidth
- D. More resistant to noise

51. An engineer decomposes a periodic square wave into sinusoidal harmonics using a:

- A. Z-transform
- B. Karnaugh map
- C. Power triangle
- D. Fourier series

52. Several signals share one cable, each using a separate frequency band simultaneously. This is:

- A. Time division multiplexing
- B. Code division multiplexing
- C. Frequency division multiplexing
- D. Pulse position only

53. A network engineer wants higher data rate on a fixed-bandwidth channel and, per Shannon-Hartley, must improve the:

- A. Signal-to-noise ratio
- B. Cable length
- C. Carrier color
- D. Number of users

54. A technician converts binary 11001 to decimal and obtains:

- A. 21
- B. 25
- C. 27
- D. 54

55. A logic designer simplifies $\text{NOT}(A \text{ AND } B)$ for an OR-gate implementation. By De Morgan's theorem this becomes:

- A. $A \text{ AND } B$
- B. $(\text{NOT } A) \text{ OR } (\text{NOT } B)$
- C. $A \text{ OR } B$
- D. $(\text{NOT } A) \text{ AND } (\text{NOT } B)$

56. An engineer builds a complex function using only NAND gates, which is possible because NAND is:

- A. The fastest gate
- B. The cheapest gate
- C. Functionally complete
- D. Free of delay

57. A technician needs a memory element that updates only on a clock edge to store one bit. The device is a:

- A. Resistor
- B. Logic AND gate
- C. Multiplexer
- D. Flip-flop

58. A circuit occasionally glitches because two signals meant to arrive together have unequal delays. This is a:

- A. Quantization error
- B. Steady-state error
- C. Power-factor problem
- D. Race condition

59. A designer needs reconfigurable hardware programmable after manufacture. The best choice is a(n):

- A. Fixed-function logic chip
- B. FPGA
- C. Single discrete transistor
- D. Read-only memory

60. A technician examines a star network and identifies the central hub as a:

- A. Single point of failure
- B. Fully redundant path
- C. Backup for all nodes

D. Means of zero downtime

61. A network analyst identifies the OSI layer that routes packets between different networks as the:

- A. Physical layer
- B. Session layer
- C. Presentation layer
- D. Network layer

62. A security engineer wants a system that not only detects but actively blocks malicious traffic. This is a(n):

- A. Passive monitor
- B. Intrusion prevention system
- C. Simple network switch
- D. Logging server

63. A technician ensuring transmitted data is not altered in transit is protecting which CIA pillar?

- A. Confidentiality
- B. Integrity
- C. Availability
- D. Redundancy

64. A processor's repeating cycle of retrieving, interpreting, and carrying out instructions is the:

- A. Memory refresh cycle
- B. Interrupt routine

- C. Fetch-decode-execute cycle
- D. Direct memory access

65. A system designer places frequently used data in fast memory near the CPU. This level of the hierarchy is:

- A. Secondary disk storage
- B. Cache memory
- C. Optical media
- D. Magnetic tape

66. A technician needs to transfer a large data block to memory with minimal CPU involvement. The method is:

- A. Programmed polling
- B. Direct memory access
- C. Per-byte interrupts
- D. Manual register copying

67. An engineer compares two algorithms and notes one is $O(\log n)$ and the other $O(n)$. For large inputs, the $O(\log n)$ one grows:

- A. Faster than linear
- B. At the same rate
- C. Much more slowly
- D. As the square of n

68. A program must process print jobs strictly in arrival order. The data structure to use is a:

- A. Stack
- B. Binary tree
- C. Hash table
- D. Queue

69. A recursive routine traverses a tree and must avoid infinite calls by including a:

- A. Global counter
- B. Outer loop limit
- C. Base case
- D. Hardware timer

70. A programmer needs fast access to any element by its index in a fixed collection. The structure is a(n):

- A. Array
- B. Linked list
- C. FIFO queue
- D. LIFO stack

71. A technician computes the two's complement of 4-bit 0100 (decimal 4) to represent -4 . The result is:

- A. 0100
- B. 0011
- C. 1100
- D. 1011

72. A loop, a conditional, and a sequence of statements are the three structures of:

- A. Object inheritance
- B. Network layering
- C. Memory addressing
- D. Structured programming

73. A technician converts hexadecimal 0x1F to decimal and gets:

- A. 15
- B. 16
- C. 30
- D. 31

74. An engineer needs non-volatile memory that retains boot firmware without power. This is:

- A. Static RAM
- B. Dynamic RAM
- C. ROM
- D. CPU registers

75. A logic gate outputs 1 only when its two inputs differ. To build a parity checker, the technician uses the:

- A. AND gate
- B. XOR gate
- C. NOR gate
- D. NOT gate

76. A technician searches a sorted list of 512 elements using binary search. The maximum number of comparisons is about:

- A. 512
- B. 9
- C. 256
- D. 64

77. A delta-connected source has a phase current of 10 A. The technician measures a line current of approximately:

- A. 10 A
- B. 5.8 A
- C. 17.3 A
- D. 30 A

78. A microcontroller's 10-bit address bus can directly address how many memory locations?

- A. 1,024
- B. 10
- C. 100
- D. 512

79. An algorithm's running time grows with the square of its input size. Its complexity is:

- A. $O(1)$
- B. $O(\log n)$
- C. $O(n^2)$
- D. $O(n)$

80. An ideal transformer delivers 150 W to its load. The approximate primary power drawn is:

- A. 300 W
- B. 75 W
- C. 37.5 W
- D. 150 W

81. A technician notes that a brief pulse in time spreads across a wide range of frequencies. This reflects the:

- A. Nyquist sampling limit
- B. Power-factor relationship
- C. Resonance condition
- D. Inverse time-frequency relationship

82. An induction motor at 6% slip with synchronous speed 1200 rpm turns at approximately:

- A. 1200 rpm
- B. 72 rpm
- C. 1128 rpm
- D. 1272 rpm

83. A common-emitter amplifier is selected as a general-purpose stage because it offers:

- A. High voltage and current gain
- B. Unity gain for buffering only
- C. No gain at all
- D. Direct rectification

84. A technician finds a magnetic field circling a current-carrying wire and determines its direction with the:

- A. Right-hand rule
- B. Coulomb inverse-square law
- C. Ohmic voltage rule
- D. Superposition principle

85. Two parallel impedances in an AC circuit are combined by the technician using:

- A. Direct addition of values
- B. Subtraction of magnitudes
- C. Multiplication of angles
- D. Reciprocals, like parallel resistors

86. A 5-bit register holds a maximum unsigned decimal value of:

- A. 32
- B. 31
- C. 16
- D. 64

87. A penetration test differs from intrusion detection in that the test is a(n):

- A. Continuous passive monitor
- B. Proactive simulated attack
- C. Hardware firewall
- D. Automatic backup process

88. A technician observes a linear system's response right after a sudden input and notes it is dominated by the:

- A. Steady-state forced response
- B. Final settled value
- C. DC offset only
- D. Transient natural response

89. A utility uses step-up transformers at the generating station to:

- A. Convert AC into DC
- B. Increase the supply frequency
- C. Lower voltage for safety
- D. Raise voltage for efficient transmission

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

- A. NAND gate
- B. AND gate
- C. OR gate
- D. XOR gate

91. A technician measures household voltage as 120 V and wants the peak. Multiplying by $\sqrt{2}$ gives approximately:

- A. 60 V
- B. 85 V
- C. 240 V
- D. 170 V

92. A transformer's secondary impedance appears at the primary scaled by the:

- A. Turns ratio directly
- B. Inverse turns ratio
- C. Square of the turns ratio
- D. Unity factor

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

- A. Guarantees fast response
- B. Requires right half-plane poles
- C. Eliminates all error
- D. Does not ensure good performance

94. A technician needs the standard deviation, which is found by taking the square root of the:

- A. Variance
- B. Mean
- C. Median
- D. Range

95. A material with a moderate band gap whose conductivity is tuned by doping is a:

- A. Conductor
- B. Insulator
- C. Semiconductor
- D. Superconductor

96. A diode conducts when its anode is positive relative to its cathode. A technician calls this:

- A. Reverse breakdown
- B. Cutoff
- C. Forward bias
- D. Saturation blocking

97. An engineer computes expected value by weighting outcomes by probability: \$600 at 0.5 and \$400 at 0.5. The result is:

- A. \$1,000
- B. \$500
- C. \$200
- D. \$300

98. A technician needs a time constant for an RC circuit with $R = 1 \text{ k}\Omega$ and $C = 100 \text{ }\mu\text{F}$. It is:

- A. 10 ms
- B. 1 ms
- C. 100 ms
- D. 1000 ms

99. An engineer chooses a sorting algorithm for very large random data and targets the complexity class:

- A. $O(n^2)$ quadratic
- B. $O(2^n)$ exponential
- C. $O(n^3)$ cubic
- D. $O(n \log n)$ linearithmic

100. A capacitor's reactance at very high frequency approaches:

- A. Infinity, blocking the signal
- B. The resistance value
- C. A fixed negative constant
- D. Zero, passing the signal

101. A technician applies KCL at a node where 6 A enters and 4 A leaves on one branch. The current leaving on the other branch is:

- A. 10 A
- B. 2 A
- C. 24 A
- D. 0 A

102. A signal sampled below its Nyquist rate shows a false low-frequency component. This artifact is:

- A. Resonance
- B. Quantization gain
- C. Phase margin
- D. Aliasing

103. A technician converts decimal 200 to hexadecimal and obtains:

- A. 0xC8
- B. 0xC8 doubled
- C. 0x88
- D. 0x20

104. An engineer designs an anti-aliasing stage to remove frequencies above half the sampling rate before sampling. This stage is a:

- A. High-pass differentiator
- B. Low-pass filter
- C. Voltage amplifier only
- D. Digital-to-analog converter

105. A technician measures a capacitor of $8 \mu\text{F}$ at $\omega = 1000 \text{ rad/s}$ and finds a reactance magnitude of:

- A. 125Ω
- B. 8Ω
- C. 1000Ω
- D. 64Ω

106. A processor suspends its current task to run a routine in response to an external event. The trigger is a(n):

- A. Interrupt
- B. Cache miss
- C. Clock divide
- D. DMA burst

107. An engineer compares two machines with different service lives and chooses the cleanest economic method:

- A. Present worth without horizon match
- B. Simple payback ignoring interest
- C. Equivalent annual cost analysis

D. Counting replaced parts

108. A technician declines an assignment far outside their specialty, citing the ethical duty to:

A. Practice within one's competence

B. Maximize billable hours

C. Conceal the limitation

D. Accept every task

109. A signal sampled at 30 kHz can faithfully represent frequencies up to:

A. 30 kHz

B. 15 kHz

C. 60 kHz

D. 7.5 kHz

110. A technician needs the equivalent resistance of a $10\ \Omega$ in series with the parallel combination of two $10\ \Omega$ resistors. The total is:

A. $30\ \Omega$

B. $15\ \Omega$

C. $20\ \Omega$

D. $5\ \Omega$

Answer Key & Full Explanations

1. A — By the power rule, the derivative of $4t^2$ is $8t$. The exponent multiplies the coefficient and decreases by one. Since capacitor current is $i = C\ dv/dt$, this derivative gives the current's time dependence.

2. B — The magnitude of $3 + j4$ is $\sqrt{3^2 + 4^2} = \sqrt{25} = 5 \Omega$. Impedance magnitude is the root of the sum of squared components. This conversion is constant in AC analysis.

3. C — The Pythagorean identity $\sin^2\theta + \cos^2\theta = 1$ holds for every angle. The other options misstate real identities. This identity underpins phasor and waveform work.

4. C — Solving simultaneous node equations as a matrix is faster and less error-prone than hand substitution, especially for three or more equations. Calculator matrix functions handle it quickly. This applies to both DC and AC circuits.

5. B — The interval in which a first-order transient completes about 63% of its change is the time constant τ . After five time constants the response is essentially complete. This pacing governs RC and RL transients.

6. A — The cross product yields a vector perpendicular to both originals, with direction given by the right-hand rule. The dot product yields a scalar instead. The cross product underlies magnetic force direction.

7. A — The number of events occurring in a fixed interval is modeled by the Poisson distribution. It is discrete and suited to counting random occurrences. This makes it apt for failure-rate modeling.

8. D — The average of squared deviations from the mean is the variance. Its square root is the standard deviation. Both quantify the spread of data about the mean.

9. D — Expected value is the probability-weighted average: $(0.8)(\$1,000) + (0.2)(\$0) = \$800$. Each outcome is weighted by its probability. This underlies economic risk analysis.

10. C — Future value is $F = P(1 + i)^n = 1000(1.05)^1 = \$1,050$. Interest is applied to the principal over one year. Compounding is the FE default.

11. B — A benefit-cost ratio above 1.0 (here 1.6) means benefits exceed costs, justifying the project. A ratio below 1.0 would not. The threshold is the decision rule.

12. C — Being offered fees by a supplier under evaluation creates a conflict of interest, and the first step is to disclose it. Engineers must act as faithful, impartial agents. Disclosure preserves the integrity of the evaluation.

13. A — Copyright protects original source code as a work of authorship, arising automatically upon creation. Patents protect inventions and trademarks protect brands. Copyright fits software code.

14. B — An engineer may seal only work prepared by them or under their direct supervision, so the correct response is to refuse to seal unsupervised work. Stamping it would be a serious violation. This rule preserves accountability.

15. C — Doping that adds free electrons as majority carriers produces N-type material. Acceptor doping creates P-type instead. Carrier type governs junction behavior.

16. A — Heating a copper conductor increases its resistance, because greater atomic vibration impedes electron flow. Semiconductors behave oppositely. This contrast is a common exam point.

17. B — Capacitance depends directly on the dielectric's permittivity, so maximizing permittivity increases capacitance. Permeability governs magnetic behavior instead. Dielectric choice is key in capacitor design.

18. C — A reverse-biased diode blocks current, so the measured current is essentially zero apart from tiny leakage. The widened depletion region prevents conduction. This one-way behavior is the basis of rectification.

19. C — Two equal parallel resistors combine to half the value: $8/2 = 4 \Omega$. Parallel resistance is always less than the smallest branch. An answer of 8Ω or more would signal an error.

20. A — Reducing a linear two-terminal network to a single voltage source in series with a resistance is the Thevenin equivalent. The Norton form uses a current source in parallel. Both simplify load analysis.

21. D — When current lags voltage by 90° , the element is an inductor, as captured by the "ELI" portion of the mnemonic. A capacitor causes current to lead instead. This phase relationship identifies the element.

22. D — Power calculations use the RMS value, which for a 100 V peak sinusoid is $100/\sqrt{2} \approx 70.7$ V. Using the peak would overstate the power. RMS is the equivalent DC value delivering the same power.

23. A — A series RLC circuit draws maximum current at the frequency where reactances cancel — resonance — leaving minimum, purely resistive impedance. Maximum current is the signature of series resonance. The resonant frequency depends only on L and C.

24. B — The Laplace transform converts differential equations into algebraic ones, since differentiation becomes multiplication by s. This turns calculus into algebra. It is the engine of transient analysis.

25. B — The Nyquist rate is twice the highest frequency: 2×10 kHz = 20 kHz. Sampling at least this fast prevents aliasing. The factor of two is the key threshold.

26. A — Passing 50 Hz while blocking 20 kHz interference requires a low-pass filter, which passes low frequencies and attenuates high ones. A high-pass filter would do the reverse. The cutoff is set between the two.

27. B — A denominator root at $s = -5$ is a pole of the system, where the response tends toward infinity. Zeros are numerator roots. Pole location determines stability and frequency behavior.

28. C — Selecting a very narrow band requires a high quality factor Q, giving a sharp resonant peak. Low Q gives a broad response. Q is inversely related to bandwidth.

29. B — A conducting silicon diode is modeled with a constant 0.7 V forward drop for hand calculations. This is accurate enough and far faster than the exponential equation. The ideal model assumes zero drop.

30. D — A voltage follower buffers a source from a low-impedance load with unity voltage gain. Its high input and low output impedance prevent loading. The common-emitter stage gives high voltage gain instead.

31. C — The rule that no current enters an op-amp's inputs follows from its infinite input impedance. This is one of the two golden rules. It enables clean KCL analysis at the inputs.

32. C — Converting DC into AC requires an inverter. A rectifier does the opposite. Matching the device to its conversion direction gives the answer.

33. A — A transistor used for digital switching toggles between cutoff (off) and saturation (fully on). The active region is for analog amplification. The operating regions distinguish switching from amplifying.

34. D — Amplifying a tiny thermocouple signal while rejecting noise common to both leads is the role of an instrumentation amplifier, valued for high common-mode rejection. A simple stage or rectifier would not reject the noise. This makes it ideal for sensor signals.

35. A — Apparent power is the hypotenuse: $S = \sqrt{P^2 + Q^2} = \sqrt{600^2 + 800^2} = \sqrt{1,000,000} = 1000$ VA. It combines real and reactive power vectorially. The units VA distinguish it from watts.

36. A — A lagging power factor from an inductive motor is corrected by adding capacitors, which supply reactive power locally and reduce source current. Adding more inductance would worsen it. This lowers losses and voltage drop.

37. C — In a wye connection, line voltage is $\sqrt{3}$ times phase voltage: $120 \times 1.732 \approx 208$ V. This is the familiar 120/208 V system. The $\sqrt{3}$ applies to voltage in wye.

38. A — 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.

39. D — Secondary voltage scales with the turns ratio: $V_s = 120 \times (400/100) = 120 \times 4 = 480$ V. More secondary turns step the voltage up. The current correspondingly steps down.

40. C — A motor running at constant speed regardless of load is a synchronous motor, locked to the supply frequency. An induction motor's speed drops slightly with load. Constant-speed behavior identifies the synchronous machine.

41. A — A voltage induced only when magnetic flux changes is explained by Faraday's law. A static field induces nothing. This principle underlies transformers, generators, and inductors.

42. A — Force quadrupling when distance is halved is the inverse-square law: halving distance multiplies the force by four. This is Coulomb's law for charges. The inverse-square dependence defines the electric field.

43. B — A cable whose length is comparable to the signal wavelength must be treated as a transmission line. At low frequencies a short cable needs no such treatment. Recognizing this regime is the key judgment.

44. D — A line is matched, with no reflections, when the load impedance equals the line's characteristic impedance. Characteristic impedance depends on geometry, not length. Matching is the central goal of high-frequency design.

45. D — A system that measures its output and adjusts to reduce error automatically is a closed-loop feedback system. An open-loop system cannot self-correct. Feedback gives control systems their accuracy.

46. B — Closed-loop gain with unity feedback is $G/(1 + G) = 19/(1 + 19) = 19/20 = 0.95$. Negative feedback reduces gain while improving stability. This formula answers many control questions.

47. A — A system with all closed-loop poles in the left half-plane is stable, returning to equilibrium after a disturbance. A right-half-plane pole would mean instability. This pole criterion is the bedrock of stability analysis.

48. A — A Bode plot shows gain and phase versus frequency on logarithmic axes, used to assess stability margins. It is a standard control-analysis tool. Margins are read directly from it.

49. B — Shifting an audio signal onto a high-frequency carrier is modulation, which enables practical transmission. Quantization and multiplexing are different processes. Modulation underlies all radio communication.

50. D — FM is chosen for noisy links because it is more resistant to noise, since information rides on frequency rather than amplitude. The trade-off is wider bandwidth. This noise immunity is FM's key advantage.

51. D — A periodic square wave is decomposed into sinusoidal harmonics using a Fourier series, which applies to periodic signals. The Fourier transform handles non-periodic signals. Both reveal frequency content.

52. C — Signals sharing one cable in separate frequency bands simultaneously use Frequency Division Multiplexing. TDM divides time and CDM uses codes. The shared dimension identifies the technique.

53. A — On a fixed-bandwidth channel, the Shannon-Hartley theorem says higher data rate requires improving the signal-to-noise ratio. Capacity grows with both bandwidth and SNR. This sets the ceiling on transmission.

54. B — Binary 11001 equals $16 + 8 + 0 + 0 + 1 = 25$ in decimal. Summing the place values of the set bits (positions 4, 3, and 0) gives the result. Base conversion is a routine digital-systems skill.

55. B — De Morgan's theorem gives $\text{NOT}(A \text{ AND } B) = (\text{NOT } A) \text{ OR } (\text{NOT } B)$, enabling an OR-gate implementation. It converts an AND complement into an OR of complements. This identity is central to logic simplification.

56. C — Building a complex function from NAND gates alone is possible because NAND is functionally complete. NOR shares this property. This universality makes NAND fundamental in integrated circuits.

57. D — A memory element that updates only on a clock edge to store one bit is a flip-flop. Gates and multiplexers are combinational and have no memory. Flip-flops give sequential circuits their state.

58. D — A glitch from unequal delays for signals meant to arrive together is a race condition, arising from timing rather than logic errors. Synchronous design is the standard defense. These faults are intermittent.

59. B — Reconfigurable hardware programmable after manufacture is an FPGA. Fixed-function chips and ROM cannot be rearranged this way. Reconfigurability is the FPGA's defining advantage.

60. A — In a star network, 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.

61. D — The Network layer of the OSI model routes packets between different networks. The Physical layer moves bits and higher layers manage sessions and applications. Routing is the Network layer's defining role.

62. B — A system that detects and actively blocks malicious traffic is an intrusion prevention system. A detection system only monitors and alerts. The distinction is action versus observation.

63. B — Ensuring data is not altered in transit protects Integrity in the CIA triad. Confidentiality concerns secrecy and Availability concerns access. Each goal maps to one pillar.

64. C — The repeating cycle of retrieving, interpreting, and carrying out instructions is the fetch-decode-execute cycle. Paced by the clock, it is the processor's fundamental operation. It is the rhythm of computation.

65. B — Frequently used data placed in fast memory near the CPU resides in cache. Cache is smaller and faster than main memory. This exploits the principle of locality.

66. B — Transferring a large data block with minimal CPU involvement is best done with Direct Memory Access. Polling and per-byte interrupts tie up the processor. DMA is the most efficient for bulk transfers.

67. C — $O(\log n)$ grows much more slowly than $O(n)$, so a logarithmic algorithm scales far better for large inputs. Doubling the input adds only a constant to a logarithmic count. Lower-order complexity is better at scale.

68. D — Processing print jobs strictly in arrival order requires a queue, which follows First-In-First-Out order. A stack is LIFO instead. Queues model arrival-order processing.

69. C — A recursive routine must include a base case to stop recursion and avoid infinite calls. The base case must be reachable. Identifying it first is essential when writing recursion.

70. A — Fast access to any element by index in a fixed collection is provided by an array, whose contiguous storage allows direct indexed access. A linked list requires sequential traversal. Arrays trade this for slower middle insertion.

71. C — Two's complement of 0100 (4): invert to 1011, add 1 to get 1100, representing -4 . This method lets subtraction use addition hardware. The leading 1 marks it negative.

72. D — A loop, a conditional, and a sequence are the three control structures of structured programming: iteration, selection, and sequence. Together they express any computation. Recognizing them is key to tracing logic.

73. D — Hex $0x1F$ equals $1 \times 16 + 15 = 31$ in decimal, where F is 15. Each hex digit is weighted by a power of 16. Hex-to-decimal conversion is a routine skill.

74. C — Non-volatile memory that retains boot firmware without power is ROM. SRAM, DRAM, and registers are all volatile. ROM stores permanent data.

75. B — An XOR gate outputs 1 only when its inputs differ, making it the building block of parity checkers. It sums bits modulo two. This difference-detecting behavior is its defining use.

76. B — Binary search halves the range each step, so 512 elements require at most $\log_2(512) = 9$ comparisons. This $O(\log n)$ efficiency requires sorted data. Repeated halving makes the search fast.

77. C — In a delta connection, line current is $\sqrt{3}$ times phase current: $10 \times 1.732 \approx 17.3$ A. The $\sqrt{3}$ factor applies to current in delta connections. Anchoring it to the connection type prevents errors.

78. A — A 10-bit address bus addresses $2^{10} = 1,024$ distinct locations. The address bus width sets the maximum addressable memory. Each added line doubles the reach.

79. C — An algorithm whose runtime grows with the square of its input has $O(n^2)$ complexity. Such quadratic growth becomes steep for large inputs. Lower-order complexity is far better at scale.

80. D — An ideal transformer conserves power, so primary power approximately equals secondary power: about 150 W. What is gained in voltage is lost in current. The ideal model assumes equality.

81. D — A brief pulse spreading across a wide frequency range reflects the inverse time-frequency relationship: short in time means wide in bandwidth. This trade-off ultimately limits data rates. It ties Fourier analysis to channel capacity.

82. C — Actual speed is synchronous reduced by slip: $1200 \times (1 - 0.06) = 1200 \times 0.94 = 1128$ rpm. Slip is the fractional speed difference. It is essential for induction-motor torque.

83. A — The common-emitter amplifier offers high 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.

84. A — 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.

85. D — 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.

86. B — A 5-bit register holds $2^5 = 32$ distinct values, so the maximum unsigned decimal value is 31 (since 0 is included). The range runs from 0 to $2^n - 1$. This bounds the register's numbers.

87. B — A penetration test is a proactive, simulated attack to find vulnerabilities before malicious actors exploit them, unlike passive intrusion detection. The test actively probes for weaknesses. Both serve security in different ways.

88. D — Immediately after a sudden input, a linear system's response is dominated by the transient (natural) response, which decays over time. The steady-state response dominates later. This maps to homogeneous and particular ODE solutions.

89. D — Step-up transformers at the generating station raise voltage for efficient long-distance transmission, reducing current and I^2R losses. Step-down transformers near consumers lower it. Transformers enable the whole transmission scheme.

90. A — 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.

91. D — Peak voltage equals RMS times $\sqrt{2}$: $120 \times 1.414 \approx 170$ V. The RMS value is peak divided by $\sqrt{2}$, so the inverse multiplies by $\sqrt{2}$. This converts quoted RMS to the waveform peak.

92. C — A transformer's secondary impedance appears at the primary scaled by the square of the turns ratio. This lets transformers perform impedance matching. The squared relationship is a tested exam point.

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

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

95. C — A material with a moderate band gap whose conductivity is tuned by doping is a semiconductor. Conductors have negligible gaps and insulators large ones. This controllability is the basis of solid-state electronics.

96. C — 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.

97. B — Expected value is the probability-weighted average: $(0.5)(\$600) + (0.5)(\$400) = \$300 + \$200 = \$500$. Each outcome is weighted by its probability. This underlies economic risk analysis.

98. C — The time constant is $\tau = RC = 1000 \times 100 \times 10^{-6} = 0.1 \text{ s} = 100 \text{ ms}$. After one time constant the response completes about 63% of its change. This governs RC transients.

99. D — The fastest practical average performance for large random data is $O(n \log n)$, achieved by efficient sorts. Quadratic and worse classes are too slow at scale. Linearithmic time is the target.

100. D — A capacitor's reactance is $1/(\omega C)$, which approaches zero at very high frequency, so it passes high-frequency signals. At low frequency the reactance is large. This frequency dependence underlies filtering.

101. B — By KCL, 6 A enters and 4 A leaves on one branch, so the other branch carries $6 - 4 = 2$ A. Charge cannot accumulate at a node. The currents must balance.

102. D — A false low-frequency component from under-sampling is aliasing. It cannot be removed afterward. Adequate sampling rate or anti-aliasing filtering prevents it.

103. A — Decimal 200 is 11001000 in binary, which groups into hex as C8 (1100 = C, 1000 = 8), written 0xC8. Each hex digit represents four bits. Base conversion is a routine skill.

104. B — Removing frequencies above half the sampling rate before sampling, to prevent aliasing, requires an anti-aliasing low-pass filter. It eliminates the offending high frequencies. This is placed before the sampler.

105. A — Capacitive reactance is $1/(\omega C) = 1/(1000 \times 8 \times 10^{-6}) = 1/0.008 = 125 \Omega$. Reactance decreases as frequency or capacitance rises. This sets the capacitor's opposition.

106. A — 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.

107. C — 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.

108. A — Declining an assignment far 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.

109. B — A 30 kHz sampling rate can faithfully represent frequencies up to half that, the Nyquist limit: 15 kHz. Components above this would alias. Half the sampling rate is the maximum recoverable frequency.

110. B — Two 10Ω resistors in parallel give 5Ω , in series with 10Ω yields $10 + 5 = 15 \Omega$. Series and parallel rules are applied in sequence. The reduction simplifies the network.