PRACTICE EXAM 9 (110 QUESTIONS)

1. A technician finds that a circuit's output never settles and instead grows without bound. The most likely cause is a closed-loop pole located in the:

A. Left half of the complex plane

B. Origin of the plane only

C. Negative real axis exclusively

D. Right half of the complex plane

2. An engineer computes the derivative of a capacitor's voltage to find its current. For $v(t) = 6t^2$, the current is proportional to:

A. $6t$

B. $3t^2$

C. $12t$

D. $6t^2$

3. A motor draws far more current than expected for its real power output. A reading of 0.5 power factor explains this, indicating the load is:

A. Purely resistive

B. Operating at unity efficiency

C. Highly reactive

D. Drawing no reactive power

4. A technician must solve three node equations quickly and accurately. The best approach is to:

A. Use a matrix and the calculator's solver

B. Guess values and iterate by hand

C. Ignore one equation to simplify

D. Convert all to a single equation

5. A first-order circuit reaches about 63% of its final value in 3 ms. Its time constant is:

A. 1 ms

B. 3 ms

C. 15 ms

D. 0.63 ms

6. A complex impedance 8 + j6 must be expressed by magnitude. The magnitude is:

A. 14

B. 10

C. 8

D. 48

7. A reliability engineer counts random equipment failures per month. The fitting probability distribution is the:

A. Poisson distribution

B. Continuous uniform distribution

C. Sinusoidal distribution

D. Linear distribution

8. A data analyst reports spread in the original measurement units. The correct measure is the:

A. Variance

B. Mean

C. Standard deviation

D. Mode

9. A budget uses the expected value of a payoff: \$900 at probability 0.6 and \$0 at 0.4. The expected value is:

A. \$540

B. \$900

C. \$360

D. \$450

10. A loan must be repaid in equal annual installments. The interest factor that gives the payment from the present amount is:

A. (P/F, i, n)

B. (F/A, i, n)

C. (P/A, i, n)

D. (A/P, i, n)

11. A plant evaluates a project with a benefit-cost ratio of 0.9. The economic conclusion is that:

A. Benefits strongly exceed costs

B. The project breaks even

C. The value doubles annually

D. Costs exceed the benefits

12. An engineer is offered a gift by a contractor whose bid they will evaluate. The proper response is to:

A. Accept it quietly as customary

B. Decline or disclose the conflict

C. Evaluate the bid favorably

D. Resign from the evaluation panel

13. A startup wants protection for a unique manufacturing process and is willing to risk reverse engineering rather than disclose it. The fitting IP choice is a:

A. Patent

B. Copyright

C. Trademark

D. Trade secret

14. An engineer discovers a sealed design that endangers the public. The correct first action is to:

A. Ignore it as already sealed

B. Quietly fix it without notice

C. Raise the concern through proper channels

D. Contact the press immediately

15. A diode is suspected of being installed backward in a rectifier that produces no output. Testing shows the diode is reverse biased, which means it is:

A. Conducting heavily

B. Amplifying the signal

C. Blocking current

D. Oscillating rapidly

16. A copper wire's resistance rises after the equipment warms up. This behavior is expected because in conductors, heating:

A. Frees additional carriers

B. Has no effect on resistance

C. Drops resistance to zero

D. Increases atomic vibration and resistance

17. A capacitor's stored charge for a given voltage must be increased. The dielectric property to raise is the:

A. Magnetic permeability

B. Thermal conductivity

C. Electrical resistivity

D. Electric permittivity

18. A technician needs majority carriers that are positive. The semiconductor type to select is:

A. N-type

B. P-type

C. Intrinsic silicon

D. An insulator

19. A node has 4 A and 3 A entering and one branch leaving. By KCL, the leaving current is:

A. 1 A

B. 12 A

C. 7 A

D. 0 A

20. A complex two-terminal network must be replaced by one current source in parallel with a resistance. This is the:

A. Thevenin equivalent

B. Superposition model

C. Resonant equivalent

D. Norton equivalent

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

A. Resistor

B. Capacitor

C. Ideal source

D. Inductor

22. A power calculation needs the effective voltage of a 170 V peak sinusoid. The value to use is approximately:

A. 120 V

B. 240 V

C. 170 V

D. 85 V

23. A series RLC circuit draws maximum current at one frequency, where its impedance is:

A. Maximum and reactive

B. Minimum and purely resistive

C. Infinite, blocking current

D. Negative and inductive

24. A differential equation describing a transient is hard to solve directly. The tool that converts it to algebra is the:

A. Fourier series

B. Laplace transform

C. Z-transform only

D. Karnaugh map

25. A sampled audio system must capture frequencies up to 15 kHz. The minimum sampling rate is:

A. 15 kHz

B. 7.5 kHz

C. 30 kHz

D. 60 kHz

26. A noise component at 25 kHz must be removed while a 100 Hz signal is preserved. The filter required is a:

A. High-pass filter

B. Low-pass filter

C. All-pass filter

D. Pure differentiator

27. A transfer function denominator is zero at $s = -2$. This value of s is a:

A. Zero of the system

B. Pole of the system

C. Gain margin

D. Steady-state error

28. A resonant circuit must select a very narrow band. The design requires a:

A. Low quality factor

B. Broad bandwidth

C. High quality factor

D. Purely resistive load

29. A conducting silicon diode is modeled in hand calculations with a forward drop of:

A. 0.7 V

B. 0.0 V

C. 5.0 V

D. 12.0 V

30. An amplifier must isolate a high-impedance source from a low-impedance load without changing voltage level. The configuration is a:

A. Common-emitter stage

B. Voltage follower

C. Tuned amplifier

D. Class-C switcher

31. An op-amp circuit is analyzed assuming no current enters its inputs. This rule follows from the op-amp's:

A. Zero output impedance

B. Negative supply rail

C. Infinite input impedance

D. Finite open-loop gain

32. A battery must power an AC appliance. The required power-electronic device is a(n):

A. Rectifier

B. Inverter

C. Forward diode

D. Linear regulator

33. A transistor used as a digital switch operates between which two regions?

A. Cutoff and saturation

B. Active and breakdown

C. Active region only

D. Forward and reverse bias

34. A weak sensor signal must be amplified while rejecting noise common to both leads. The device is an:

A. Half-wave rectifier

B. Instrumentation amplifier

C. Simple common-base stage

D. Passive RC filter

35. A load shows real power 700 W and reactive power 700 VAR. The apparent power is approximately:

A. 1400 VA

B. 990 VA

C. 700 VA

D. 0 VA

36. A motor with lagging power factor is corrected by adding:

A. Capacitors to supply reactive power

B. More inductive load

C. Series resistance

D. A second identical motor

37. A wye-connected source has a phase voltage of 277 V. The line voltage is approximately:

A. 277 V

B. 480 V

C. 160 V

D. 831 V

38. A utility raises transmission voltage to reduce, for fixed power, the:

A. Supply frequency

B. Load-end voltage

C. Transformer count

D. Current and I^2R losses

39. A transformer with 200 primary and 50 secondary turns is fed 240 V. The secondary voltage is:

A. 960 V

B. 60 V

C. 240 V

D. 480 V

40. A motor's speed drops slightly as load increases, and the slip grows. The motor is most likely:

A. A synchronous motor

B. A DC shunt motor

C. An induction motor

D. A stepper motor

41. A coil produces voltage only when the magnetic flux through it changes. This is:

A. Coulomb's law

B. Faraday's law

C. Ohm's law

D. Gauss's law for electricity

42. Two charges are moved twice as far apart, and the force drops to one-quarter. This confirms the:

A. Linear distance law

B. Inverse-square law

C. Cube-law dependence

D. Distance independence

43. A high-frequency signal on a cable comparable in length to its wavelength must be modeled as a:

A. Lumped resistor

B. Pure capacitor

C. Transmission line

D. DC short circuit

44. A transmission line shows no reflections when its load impedance equals the:

A. Characteristic impedance

B. Source voltage

C. Total line length

D. Operating frequency

45. A system must automatically correct for disturbances by measuring its output. This requires a:

A. Pure feedforward path

B. Manual override

C. Closed-loop feedback design

D. Single open-loop chain

46. A negative-feedback system has G = 9 and H = 1. Its closed-loop gain is approximately:

A. 9

B. 10

C. 0.9

D. 1.0

47. A technician confirms all poles lie in the left half-plane. The system is:

A. Stable

B. Unstable

C. Marginal only

D. Oscillating without bound

48. An engineer reads gain and phase versus frequency to evaluate stability margins from a:

A. Smith chart

B. Karnaugh map

C. Cash-flow diagram

D. Bode plot

49. A 1 kHz audio tone is shifted onto a 950 MHz carrier for broadcast. This process is:

A. Modulation

B. Quantization

C. Multiplexing

D. Rectification

50. FM is preferred over AM for a noisy channel because FM:

A. Resists noise better

B. Uses far less bandwidth

C. Needs no carrier

D. Cannot be demodulated

51. A periodic waveform is broken into a fundamental and harmonics using a:

A. Z-transform

B. Fourier series

C. Power triangle

D. Karnaugh map

52. Several calls share a cable, each using a separate frequency band at the same time. This is:

A. Time division multiplexing

B. Code division multiplexing

C. Pulse position modulation

D. Frequency division multiplexing

53. On a fixed-bandwidth channel, higher data rate requires, per Shannon-Hartley, improving the:

A. Cable length

B. Carrier frequency

C. Number of users

D. Signal-to-noise ratio

54. Convert binary 11100 to decimal:

A. 24

B. 26

C. 28

D. 56

55. A designer simplifies NOT(A OR B) for AND-gate logic. By De Morgan's theorem this is:

A. (NOT A) AND (NOT B)

B. A AND B

C. A OR NOT B

D. (NOT A) OR (NOT B)

56. A complex function is built using only NAND gates, possible because NAND is:

A. Functionally complete

B. The fastest gate

C. The cheapest gate

D. Free of delay

57. A memory element must hold one bit and update on a clock edge. The device is a:

A. Resistor

B. Logic OR gate

C. Multiplexer

D. Flip-flop

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

A. Race condition

B. Steady-state error

C. Quantization error

D. Power-factor issue

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

A. Fixed-function chip

B. FPGA

C. Discrete transistor

D. Read-only memory

60. In a star network, a failed central hub will:

A. Affect only one device

B. Disable the entire network

C. Reroute traffic automatically

D. Improve performance

61. The OSI layer that routes packets between different networks is the:

A. Network layer

B. Physical layer

C. Session layer

D. Presentation layer

62. A security tool that detects and actively blocks malicious traffic is a(n):

A. Intrusion prevention system

B. Passive logging monitor

C. Simple network switch

D. Standard firewall log

63. Ensuring transmitted data is not altered in transit protects which CIA pillar?

A. Confidentiality

B. Integrity

C. Availability

D. Redundancy

64. A processor repeatedly retrieves, interprets, and carries out instructions in the:

A. Memory refresh cycle

B. Interrupt routine

C. Fetch-decode-execute cycle

D. Direct memory access

65. Frequently used data is held near the CPU in fast memory called:

A. Secondary disk storage

B. Optical media

C. Cache memory

D. Magnetic tape

66. A large data block must move to memory with minimal CPU involvement. The method is:

A. Programmed polling

B. Per-byte interrupts

C. Manual register copying

D. Direct memory access

67. Comparing O(log n) to O(n), the logarithmic algorithm for large inputs grows:

A. Faster than linear

B. At the same rate

C. As the square of n

D. Much more slowly

68. Print jobs must be processed strictly in arrival order. The data structure is a:

A. Stack

B. Binary tree

C. Queue

D. Hash table

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

A. Base case

B. Global counter

C. Outer loop limit

D. Hardware timer

70. Fast access to any element by index in a fixed collection is provided by a(n):

A. Linked list

B. FIFO queue

C. Array

D. LIFO stack

71. Two's complement of 4-bit 0110 (decimal 6), representing −6, is:

A. 0110

B. 1001

C. 1010

D. 0100

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

A. Structured programming

B. Object inheritance

C. Network layering

D. Memory addressing

73. Convert hexadecimal 0x2D to decimal:

A. 29

B. 45

C. 52

D. 64

74. Non-volatile memory that retains boot firmware without power is:

A. Static RAM

B. ROM

C. Dynamic RAM

D. CPU registers

75. A gate outputs 1 only when its inputs differ. For a parity checker, the technician uses the:

A. XOR gate

B. AND gate

C. NOR gate

D. NOT gate

76. A binary search on 256 sorted elements requires at most about how many comparisons?

A. 8

B. 256

C. 128

D. 64

77. A delta source has a phase current of 15 A. The line current is approximately:

A. 15 A

B. 8.7 A

C. 45 A

D. 26 A

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

A. 12

B. 256

C. 4,096

D. 1,024

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

A. $O(n^2)$

B. O(1)

C. O(log n)

D. O(n)

80. An ideal transformer delivers 250 W to a load. The primary power drawn is approximately:

A. 500 W

B. 125 W

C. 62.5 W

D. 250 W

81. A very brief pulse in time occupies a frequency spectrum that is:

A. Wide in bandwidth

B. A single frequency only

C. At zero frequency

D. Equally narrow

82. An induction motor at 5% slip with 1800 rpm synchronous speed turns at about:

A. 1710 rpm

B. 90 rpm

C. 1890 rpm

D. 1800 rpm

83. A general-purpose amplifier stage offering high voltage and current gain is the:

A. Common collector

B. Emitter follower

C. Common base

D. Common emitter

84. A magnetic field circling a wire has a direction found by the:

A. Coulomb inverse-square law

B. Ohmic voltage rule

C. Right-hand rule

D. Superposition principle

85. Parallel impedances in an AC circuit are combined using:

A. Direct addition of values

B. Subtraction of magnitudes

C. Reciprocals, like parallel resistors

D. Multiplication of angles

86. A 6-bit register holds a maximum unsigned decimal value of:

A. 64

B. 32

C. 16

D. 63

87. A penetration test, unlike intrusion detection, is a(n):

A. Continuous passive monitor

B. Hardware firewall appliance

C. Automatic backup process

D. Proactive simulated attack

88. A linear system's response right after a sudden input is dominated by the:

A. Steady-state forced response

B. Final settled value

C. Transient natural response

D. DC offset only

89. Step-up transformers at a generating station serve to:

A. Convert AC into DC

B. Increase supply frequency

C. Lower voltage for safety

D. Raise voltage for efficient transmission

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

A. AND gate

B. NAND gate

C. OR gate

D. XOR gate

91. A household outlet reads 120 V. Its peak voltage is approximately 120 multiplied by:

A. 0.707

B. $\sqrt{2}$ (about 1.414)

C. 2.0

D. 0.5

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 error. This shows that stability:

A. Guarantees fast response

B. Requires right half-plane poles

C. Eliminates all error

D. Does not ensure good performance

94. The standard deviation is found by taking the square root of the:

A. Mean

B. Variance

C. Median

D. Range

95. A material with a moderate band gap tunable 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. This is:

A. Reverse breakdown

B. Cutoff

C. Saturation blocking

D. Forward bias

97. Expected value is computed by weighting outcomes by probability: \$800 at 0.25 and \$0 at 0.75. The result is:

A. \$800

B. \$600

C. \$400

D. \$200

98. An RC circuit with R = 10 kΩ and C = 2 μF has a time constant of:

A. 20 ms

B. 5 ms

C. 0.2 ms

D. 50 ms

99. A sorting algorithm for very large random data should target 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 signal sampled below its Nyquist rate shows a false low-frequency component. This is:

A. Resonance

B. Aliasing

C. Quantization gain

D. Phase margin

102. An anti-aliasing stage removing frequencies above half the sampling rate before sampling is a:

A. High-pass differentiator

B. Voltage amplifier only

C. Low-pass filter

D. Digital-to-analog converter

103. A processor suspends its task to run a routine triggered by an external event. The trigger is a(n):

A. Cache miss

B. Clock divide

C. DMA burst

D. Interrupt

104. A capacitor of 4 μF at ω = 2500 rad/s has a reactance magnitude of:

A. 4 Ω

B. 250 Ω

C. 100 Ω

D. 1000 Ω

105. An engineer compares two machines with different service lives and uses the cleanest method:

A. Equivalent annual cost analysis

B. Present worth without horizon match

C. Simple payback ignoring interest

D. Counting replaced parts

106. A technician declines an assignment outside their specialty, citing the duty to:

A. Practice within one's competence

B. Maximize billable hours

C. Conceal the limitation

D. Accept every task

107. A signal sampled at 40 kHz can faithfully represent frequencies up to:

A. 40 kHz

B. 20 kHz

C. 80 kHz

D. 10 kHz

108. A node has 8 A entering and 5 A leaving on one branch. By KCL, the other branch carries:

A. 3 A

B. 13 A

C. 40 A

D. 0 A

109. 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

110. A NAND-only implementation of arbitrary logic is possible because the NAND gate is:

A. The fastest available gate

B. Built from one transistor

C. Free of propagation delay

D. Functionally complete

Answer Key & Full Explanations

1. D — An output that grows without bound indicates instability, caused by a closed-loop pole in the right half of the complex plane (positive real part). Stability requires all poles in the left half-plane. A single right-half-plane pole is enough to cause runaway growth.

2. C — By the power rule, the derivative of $6t^2$ is $12t$. Since capacitor current is $i = C\,dv/dt$, the current is proportional to $12t$. The exponent multiplies the coefficient and decreases by one.

3. C — A power factor of 0.5 means only half the apparent power does useful work, so the load is highly reactive, drawing large current for its real output. Inductive loads cause this. Capacitor correction would raise the power factor.

4. A — Solving three node equations is fastest and most accurate using a matrix and the calculator's solver. Hand iteration is slow and error-prone. Matrix methods are the standard approach for three or more equations.

5. B — A first-order response reaches about 63% of its final value in exactly one time constant, so $\tau = 3$ ms here. After five time constants the response is essentially complete. This pacing governs RC and RL transients.

6. B — The magnitude of $8 + j6$ is $\sqrt{(8^2 + 6^2)} = \sqrt{100} = 10$. Impedance magnitude is the root of the sum of squared components. This is the classic 6-8-10 triangle.

7. A — Counting random failures per fixed interval is modeled by the Poisson distribution. It is discrete and suited to event counts. The uniform and sinusoidal options do not fit count data.

8. C — The standard deviation reports spread in the original measurement units, being the square root of the variance. Variance is in squared units. Standard deviation is the most informative spread measure.

9. A — Expected value is the probability-weighted average: (0.6)(\$900) + (0.4)(\$0) = \$540. Each outcome is weighted by its probability. This underlies economic risk analysis.

10. D — The factor (A/P, i, n) gives the equal annual payment from a present amount, reading "find A given P." This is exactly loan repayment. Matching factor notation to the conversion is the core skill.

11. D — A benefit-cost ratio below 1.0 (here 0.9) means costs exceed benefits, so the project is not justified. Only above 1.0 justifies a project. The threshold is the decision rule.

12. B — A gift from a contractor whose bid will be evaluated creates a conflict of interest; the proper response is to decline or disclose it. Engineers must remain impartial agents. Disclosure protects the evaluation's integrity.

13. D — Protecting a unique process without disclosure, accepting the reverse-engineering risk, describes a trade secret. A patent would require public disclosure and expire. The trade-off between the two is a frequent exam topic.

14. C — Discovering a sealed design that endangers the public obligates the engineer to raise the concern through proper channels. Public safety is the paramount duty. Ignoring it or going straight to the press first would be improper.

15. C — A reverse-biased diode blocks current, which explains a rectifier producing no output if the diode is installed backward. The widened depletion region prevents conduction. Forward bias is required for the diode to pass current.

16. D — A copper conductor's resistance rises with temperature because heating increases atomic vibration, impeding electron flow. Semiconductors behave oppositely. This contrast is a common exam point.

17. D — Increasing a capacitor's stored charge for a given voltage means increasing capacitance, which depends directly on the dielectric's electric permittivity. Higher permittivity yields greater capacitance. Permeability governs magnetic behavior instead.

18. B — Positive majority carriers (holes) are found in P-type semiconductors, created by acceptor doping. N-type material has electrons as majority carriers. Carrier type governs junction behavior.

19. C — By KCL, current in equals current out: (4 + 3) entering means 7 A must leave. Charge cannot accumulate at a node. The single leaving branch therefore carries 7 A.

20. D — Replacing a network with a current source in parallel with a resistance is the Norton equivalent. The Thevenin form uses a voltage source in series. Both simplify load analysis and are interchangeable.

21. D — When voltage leads current by 90°, the component 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. A — The effective (RMS) value of a 170 V peak sinusoid is $170/\sqrt{2} \approx 120$ V. This is why standard outlet voltage is quoted as 120 V RMS. Power calculations always use RMS.

23. B — A series RLC circuit draws maximum current at resonance, where reactances cancel and the impedance is minimum and purely resistive. A parallel resonant circuit behaves oppositely. The resonant frequency depends only on L and C.

24. B — The Laplace transform converts a hard-to-solve differential equation into an algebraic one, since differentiation becomes multiplication by s. The Z-transform is its discrete counterpart. This makes transient problems tractable.

25. C — The Nyquist rate is twice the highest frequency: 2×15 kHz = 30 kHz. Sampling at least this fast prevents aliasing. The factor of two is the key threshold.

26. B — Removing 25 kHz noise while preserving a 100 Hz signal requires a low-pass filter, which passes low frequencies and blocks high ones. A high-pass filter would do the reverse. The cutoff is set between the two.

27. B — A denominator root at $s = -2$ 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. A — A conducting silicon diode is modeled with a constant 0.7 V forward drop in hand calculations. This is accurate enough and far faster than the exponential equation. The ideal model assumes zero drop.

30. B — Isolating a high-impedance source from a low-impedance load without changing voltage is the job of a voltage follower (buffer). 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. B — Powering an AC appliance from a battery requires an inverter to convert DC into AC. A rectifier does the opposite. Matching the device to its conversion direction gives the answer.

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

34. B — Amplifying a weak sensor 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. B — Apparent power is the hypotenuse: $S = \sqrt{(P^2 + Q^2)} = \sqrt{(700^2 + 700^2)} = \sqrt{980{,}000} \approx 990$ 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. B — In a wye connection, line voltage is √3 times phase voltage: 277 × 1.732 ≈ 480 V. This is the common 277/480 V system. The √3 applies to voltage in wye.

38. 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.

39. B — Secondary voltage scales with the turns ratio: V_s = 240 × (50/200) = 240 × 0.25 = 60 V. Fewer secondary turns step the voltage down. The current correspondingly steps up.

40. C — A motor whose speed drops slightly as load increases, with growing slip, is an induction motor. A synchronous motor holds constant speed regardless of load. Slip-versus-load behavior identifies the induction machine.

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

42. B — Force dropping to one-quarter when distance doubles confirms the inverse-square law: doubling distance divides force by four. This is Coulomb's law for charges. The inverse-square dependence defines the electric field.

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

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

45. C — Automatically correcting for disturbances by measuring the output requires a closed-loop feedback design. An open-loop system cannot self-correct. Feedback gives control systems their accuracy.

46. C — Closed-loop gain is $G/(1 + GH) = 9/(1 + 9\times1) = 9/10 = 0.9$. Negative feedback reduces gain while improving stability. This formula answers many control questions.

47. A — A system with all 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. D — Gain and phase versus frequency, used to assess stability margins, are read from a Bode plot. It is a standard control-analysis tool. Margins are read directly from it.

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

50. A — FM is preferred for noisy channels because it resists noise better, since information rides on frequency rather than amplitude. The trade-off is wider bandwidth. This noise immunity is FM's key advantage.

51. B — A periodic waveform is broken into a fundamental and harmonics using a Fourier series, which applies to periodic signals. The Fourier transform handles non-periodic signals. Both reveal frequency content.

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

53. D — 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. C — Binary 11100 equals 16 + 8 + 4 + 0 + 0 = 28 in decimal. Summing the set bits' place values gives the value. Base conversion is a routine skill.

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

56. A — 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 holds one bit and updates on a clock edge is a flip-flop. Gates and multiplexers are combinational and have no memory. Flip-flops give sequential circuits their state.

58. A — 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. B — 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. A — 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. A — A tool 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. C — Frequently used data held near the CPU in fast memory resides in cache. Cache is smaller and faster than main memory. This exploits the principle of locality.

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

68. C — 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. A — 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. C — 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 0110 (6): invert to 1001, add 1 to get 1010, representing −6. This method lets subtraction use addition hardware. The leading 1 marks it negative.

72. A — 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. B — Hex 0x2D equals 2×16 + 13 = 45 in decimal, where D is 13. Each hex digit is weighted by a power of 16. Hex-to-decimal conversion is a routine skill.

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

75. A — 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. A — Binary search halves the range each step, so 256 elements require at most $\log_2(256) = 8$ comparisons. This O(log n) efficiency requires sorted data. Repeated halving makes the search fast.

77. D — In a delta connection, line current is √3 times phase current: 15 × 1.732 ≈ 26 A. The √3 factor applies to current in delta connections. Anchoring it to the connection type prevents errors.

78. C — 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.

79. A — 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 250 W. What is gained in voltage is lost in current. The ideal model assumes equality.

81. A — By the inverse time-frequency relationship, a very brief pulse occupies a wide bandwidth. Short pulses demand more spectrum. This trade-off ultimately limits data rates.

82. A — Actual speed is synchronous reduced by slip: $1800 \times (1 - 0.05) = 1800 \times 0.95 = 1710$ rpm. Slip is the fractional speed difference. It is essential for induction-motor torque.

83. D — 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. C — The direction of the magnetic field circling a 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. C — 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. D — A 6-bit register holds $2^6 = 64$ distinct values, so the maximum unsigned decimal value is 63 (since 0 is included). The range runs from 0 to $2^n - 1$. This bounds the register's numbers.

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

88. C — 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 a generating station raise voltage for efficient transmission, reducing current and I^2R losses. Step-down transformers near consumers lower it. Transformers enable the whole transmission scheme.

90. 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.

91. B — Peak voltage equals RMS times √2: 120 × 1.414 ≈ 170 V. The RMS value is peak divided by √2, so the inverse multiplies by √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 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. B — 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 tunable by doping is a semiconductor. Conductors have negligible gaps and insulators large ones. This controllability is the basis of solid-state electronics.

96. D — 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. D — Expected value is the probability-weighted average: (0.25)(\$800) + (0.75)(\$0) = \$200. Each outcome is weighted by its probability. This underlies economic risk analysis.

98. A — The time constant is $\tau = RC = 10{,}000 \times 2\times10^{-6} = 0.02$ s = 20 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 — A false low-frequency component from under-sampling is aliasing. It cannot be removed afterward. Adequate sampling rate or anti-aliasing filtering prevents it.

102. C — 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.

103. D — 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.

104. C — Capacitive reactance is $1/(\omega C) = 1/(2500 \times 4\times10^{-6}) = 1/0.01 = 100\ \Omega$. Reactance decreases as frequency or capacitance rises. This sets the capacitor's opposition.

105. A — 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.

106. A — Declining an assignment 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.

107. B — A 40 kHz sampling rate can faithfully represent frequencies up to half that, the Nyquist limit: 20 kHz. Components above this would alias. Half the sampling rate is the maximum recoverable frequency.

108. A — By KCL, 8 A enters and 5 A leaves on one branch, so the other branch carries $8 - 5 = 3$ A. Charge cannot accumulate at a node. The currents must balance.

109. 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.

110. D — A NAND-only implementation of arbitrary logic is possible because the NAND gate is functionally complete. NOR shares this property. This universality makes NAND fundamental in integrated circuits.