PRACTICE EXAM 8 (110 QUESTIONS)

1. Which quantity is an intrinsic property of a material, independent of the object's dimensions?

A. Resistivity

B. Resistance

C. Total conductance

D. Voltage drop

2. The derivative of $f(x) = 7x^2$ with respect to x is:

A. $7x$

B. $14x^2$

C. 7

D. $14x$

3. For multiplying two complex numbers, which form is most efficient?

A. Polar, multiplying magnitudes and adding angles

B. Rectangular, adding the real parts

C. Rectangular, subtracting imaginary parts

D. Exponential, subtracting the exponents

4. A second-order system has a single repeated real root. Its response is:

A. Critically damped, fastest without oscillation

B. Underdamped, oscillating while settling

C. Overdamped, returning slowly without oscillation

D. Unstable, growing without bound

5. Which measure of central tendency is least affected by an extreme outlier?

A. The arithmetic mean

B. The median

C. The sum of values

D. The total range

6. The integral of $f(x) = 2x$ with respect to x is:

A. $2 + C$

B. $2x^2 + C$

C. $4x^2 + C$

D. $x^2 + C$

7. The dot product of two perpendicular vectors equals:

A. The product of their magnitudes

B. Zero

C. A vector perpendicular to both

D. Their combined length

8. Which distribution is best suited to counting the number of discrete events in a fixed interval?

A. Normal distribution

B. Poisson distribution

C. Continuous uniform distribution

D. Sinusoidal distribution

9. The sample standard deviation divides the sum of squared deviations by:

A. N, the total count

B. $N + 1$

C. The square root of N

D. $N - 1$

10. An investment yields \$1,200 with probability 0.5 and \$400 with probability 0.5. Its expected value is:

A. \$800

B. \$1,600

C. \$1,200

D. \$400

11. Which interest factor converts a present sum into an equivalent uniform annual payment?

A. (P/F, i, n)

B. (F/A, i, n)

C. (P/A, i, n)

D. (A/P, i, n)

12. A benefit-cost ratio of exactly 1.0 indicates that a project's benefits:

A. Strongly exceed its costs

B. Equal its costs

C. Fall well short of its costs

D. Cannot be evaluated

13. A nominal annual rate compounded monthly produces an effective annual rate that is:

A. Higher than the nominal rate

B. Equal to the nominal rate

C. Lower than the nominal rate

D. Always exactly zero

14. An engineer's paramount ethical obligation is to:

A. Protect public health, safety, and welfare

B. Maximize the employer's profit

C. Complete projects ahead of schedule

D. Follow client orders without exception

15. Which intellectual property type protects a brand name or logo?

A. A patent

B. A copyright

C. A trademark

D. A trade secret

16. An engineer asked to seal work they did not supervise should:

A. Refuse, sealing only supervised work

B. Seal it to help the firm meet deadlines

C. Seal it after a quick visual check

D. Delegate the sealing to a colleague

17. Which behavior violates the duty to act as a faithful agent?

A. Disclosing a potential conflict of interest

B. Declining work outside one's competence

C. Maintaining client confidentiality

D. Accepting undisclosed pay from two parties for one job

18. The majority charge carriers in an n-type semiconductor are:

A. Free electrons

B. Positive holes

C. Neutral dopant atoms

D. Bound protons

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

A. Increases due to atomic vibration

B. Decreases as carriers are freed

C. Remains exactly constant

D. Falls abruptly to zero

20. Permittivity is the material property that governs a:

A. Resistor's power dissipation

B. Inductor's magnetic energy

C. Capacitor's charge storage

D. Diode's reverse leakage

21. Carrier movement driven by a concentration gradient rather than an electric field is called:

A. Drift

B. Conduction

C. Induction

D. Diffusion

22. Kirchhoff's Current Law expresses the conservation of:

A. Energy around a loop

B. Magnetic flux in a core

C. Charge at a node

D. Power in a resistor

23. When finding a Thevenin resistance, an independent voltage source is replaced with:

A. An open circuit

B. A current source

C. A short circuit

D. A doubled resistance

24. For a sinusoid, the RMS value equals the peak value multiplied by approximately:

A. 1.414

B. 0.707

C. 0.500

D. 1.000

25. The impedance of an ideal inductor at angular frequency ω is:

A. A purely real value R

B. 1/(jωC), negative imaginary

C. Zero at all frequencies

D. jωL, positive imaginary

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

A. Maximum and purely reactive

B. Minimum and purely resistive

C. Infinite, blocking current

D. Negative and capacitive

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

A. Division by s

B. Addition of a constant

C. Multiplication by s

D. A pure time delay

28. The poles of a transfer function are the values of s that make its:

A. Numerator polynomial equal to one

B. Denominator polynomial equal to zero

C. Input reach its maximum

D. Gain margin infinite

29. 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 any margin

30. A low-pass filter passes:

A. High frequencies, blocking low

B. A single narrow band only

C. Low frequencies, blocking high

D. No frequencies at all

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

A. 0.0 V, ideal

B. 5.0 V, large fixed

C. 0.7 V, constant

D. 12.0 V, the supply

32. A common-collector (emitter-follower) amplifier is used primarily for:

A. Buffering and impedance matching

B. High voltage gain

C. High-frequency oscillation

D. AC-to-DC rectification

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

A. Zero ohms

B. A low fixed value

C. Negative

D. Infinite

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

A. AC into DC

B. DC into AC

C. DC into a higher DC

D. AC into a higher frequency

35. Real power in an AC circuit is measured in:

A. Volt-amperes (VA)

B. Watts (W)

C. Volt-amperes reactive (VAR)

D. Henries (H)

36. The power triangle relates apparent power S to real power P and reactive power Q by:

A. $S = P + Q$ added directly

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

C. S = P × Q multiplied

D. S = P − Q subtracted

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

A. 1/√3

B. 2 exactly

C. 3 exactly

D. √3 (about 1.732)

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

A. The inverse of the turns ratio

B. The turns ratio Np/Ns

C. The square of the turns ratio

D. Unity for all transformers

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

A. The power factor

B. Slip

C. The commutation angle

D. Torque ripple

40. Faraday's law states that an induced voltage arises from a changing:

A. Electric charge density

B. Resistance in the loop

C. Ambient temperature

D. Magnetic flux

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

A. The speed of sound

B. A frequency-dependent speed

C. An infinite speed

D. The speed of light

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

A. Lumped resistor

B. Transmission line

C. Pure capacitor

D. DC short circuit

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

A. Applies control without measuring output

B. Cannot reject any disturbance

C. Operates only at one frequency

D. Measures the output and feeds it back

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

A. Right half-plane

B. Upper half-plane only

C. Left half-plane

D. Exactly on the imaginary axis

45. 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 the receiver's power use

D. Eliminate all channel noise

46. Frequency modulation varies the carrier's:

A. Amplitude

B. Phase only

C. Frequency

D. Wavelength alone

47. A Fourier series decomposes a periodic signal into:

A. A fundamental and its harmonics

B. A continuous frequency band

C. Random noise components

D. A single DC term

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

A. Time slot

B. Frequency band

C. Spreading code

D. Physical wire

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

A. Cable length

B. Signal-to-noise ratio

C. Number of users

D. Carrier frequency only

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

A. A AND B unchanged

B. (NOT A) AND (NOT B)

C. (NOT A) OR (NOT B)

D. A OR B directly

51. A NAND gate is functionally complete, meaning:

A. It consumes the least power

B. It operates faster than all gates

C. Any logic function can be built from it

D. It needs no power supply

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

A. At the active clock edge

B. Continuously at all times

C. Only at power-up

D. At random intervals

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

A. Karnaugh map

B. Power triangle

C. Bode plot

D. State diagram

54. A race condition in a digital circuit arises when the outcome depends on the:

A. Number of logic gates used

B. Brand of the integrated circuit

C. Relative timing of supposedly simultaneous signals

D. Color of the circuit board

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

A. Single point of failure

B. Fully redundant path

C. Backup for every node

D. Means of zero downtime

56. The OSI model defines how many layers?

A. Seven

B. Five

C. Four

D. Ten

57. In the CIA triad, ensuring data is not improperly altered is:

A. Confidentiality

B. Integrity

C. Availability

D. Authentication

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

A. Actively blocks detected threats

B. Only logs events silently

C. Operates with no rules

D. Monitors but never acts

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

A. Power supply unit

B. Network router

C. Processor (CPU)

D. Cooling system

60. In the memory hierarchy, registers are characterized as:

A. The largest, slowest memory

B. The fastest, smallest memory

C. Non-volatile permanent storage

D. Cheaper per bit than disk

61. RAM is volatile memory, meaning it:

A. Loses its contents when powered off

B. Retains data without power

C. Can only be read, never written

D. Stores boot firmware permanently

62. Direct Memory Access improves efficiency by transferring data:

A. One bit at a time via the CPU

B. Without CPU involvement per item

C. Only after each interrupt

D. Exclusively to read-only memory

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

A. Grows linearly with input

B. Grows with the square of input

C. Grows logarithmically

D. Does not change with input size

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

A. Stack

B. Queue

C. Binary tree

D. Hash table

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

A. Produce a correct result

B. Cause a stack overflow

C. Use less memory

D. Run faster overall

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

A. Recursion

B. Compilation

C. Encryption

D. Iteration

67. 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 of value

68. Two's complement representation is standard for signed numbers because it:

A. Requires separate subtraction hardware

B. Has two representations of zero

C. Allows subtraction using addition hardware

D. Cannot represent negative values

69. An algorithm whose running time grows with the square of its input has complexity:

A. O(1)

B. O(n)

C. $O(n^2)$

D. O(log n)

70. A binary search requires that the data first be:

A. Stored entirely in registers

B. Sorted in order

C. Converted to hexadecimal

D. Duplicated across two arrays

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

A. Infinity, blocking the signal

B. The resistance value

C. Zero, passing the signal

D. A fixed negative constant

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

A. Coulomb inverse-square law

B. Ohmic voltage rule

C. Superposition principle

D. Right-hand rule

73. Parallel impedances in an AC circuit combine using:

A. Direct addition of the two values

B. Subtraction of the magnitudes

C. Multiplication of the angles

D. Reciprocals, like parallel resistors

74. A common-emitter amplifier's primary advantage is that it provides:

A. Unity gain for buffering

B. No phase change at the output

C. Substantial voltage and current gain

D. Direct rectification of AC

75. Two independent events have probabilities 0.5 and 0.4. The probability that both occur is:

A. 0.90

B. 0.20

C. 0.45

D. 0.10

76. 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. Unity in all cases

D. The square of the turns ratio

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

A. Mean

B. Median

C. Range

D. Variance

78. 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

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

A. Conductor

B. Semiconductor

C. Insulator

D. Superconductor

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

A. Twice its passband value

B. One-tenth its value

C. Half its passband value

D. Zero across the band

81. 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

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

A. The current itself

B. The voltage across it

C. The magnetic flux

D. The resistance

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

A. Zero, from infinite input impedance

B. Equal to the output current

C. Half the feedback current

D. Maximum at all times

84. Power is transmitted at high voltage primarily to:

A. Increase the line current

B. Eliminate transformers

C. Minimize I^2R losses

D. Raise the supply frequency

85. 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

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

A. Fixed permanently at manufacture

B. Limited to a single function

C. Operated with no configuration

D. Reconfigured after manufacture

87. In the TCP/IP model, how many layers are defined?

A. Seven

B. Five

C. Ten

D. Four

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

A. A single frequency only

B. Confined to zero frequency

C. Wide in bandwidth

D. Equally narrow

89. A Zener diode regulates voltage by operating in:

A. Forward conduction

B. Cutoff with no current

C. The active region

D. Reverse breakdown

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

A. Output current for motors

B. Common-mode rejection of noise

C. Switching frequency

D. Power dissipation

91. The expected value of an uncertain outcome is found by:

A. Taking only the largest outcome

B. Choosing the most optimistic case

C. Weighting outcomes by their probabilities

D. Ignoring the probabilities

92. Convert binary 10100 to decimal:

A. 18

B. 20

C. 24

D. 40

93. A transistor used for digital switching operates between which two regions?

A. Cutoff and saturation

B. Active and breakdown

C. Active region only

D. Forward and reverse bias

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

A. Does not by itself ensure good performance

B. Guarantees fast response

C. Requires right half-plane poles

D. Eliminates all steady-state error

95. A balanced delta source has a phase current of 10 A. The line current is approximately:

A. 10 A

B. 5.8 A

C. 30 A

D. 17.3 A

96. Code Division Multiplexing allows signals to share frequency and time by using:

A. Separate time slots

B. Different frequency bands

C. Unique codes per signal

D. Physically isolated channels

97. An RC circuit with R = 2 kΩ and C = 5 μF has a time constant of:

A. 10 ms

B. 0.4 ms

C. 2.5 ms

D. 40 ms

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

A. AND gate

B. OR gate

C. NAND gate

D. XOR gate

99. A purely inductive AC element has voltage that leads current by:

A. Zero degrees

B. 45 degrees

C. 90 degrees

D. 180 degrees

100. A 16-bit address bus can directly address how many memory locations?

A. 16

B. 256

C. 1,024

D. 65,536

101. An engineer declines a job outside their expertise. This reflects the duty to:

A. Maximize billable work

B. Conceal any limitations

C. Accept all assignments

D. Practice within competence

102. 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

103. A signal sampled at 16 kHz can faithfully represent frequencies up to:

A. 8 kHz

B. 16 kHz

C. 32 kHz

D. 4 kHz

104. An inverter converts:

A. DC into AC

B. AC into DC

C. DC into a lower DC

D. AC into a higher frequency

105. Convert hexadecimal 0x3C to decimal:

A. 30

B. 48

C. 56

D. 60

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

A. Present worth without horizon match

B. Equivalent annual cost analysis

C. Simple payback ignoring interest

D. Counting replaced parts

107. A diode in a circuit is reverse biased. The current through it is:

A. Large and rising with voltage

B. Essentially zero

C. Equal to the forward current

D. Oscillating at line frequency

108. A three-phase wye load draws 6 A line current at 208 V line voltage with unity power factor. The total real power is approximately:

A. 1,248 W

B. 720 W

C. 2,160 W

D. 3,600 W

109. 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

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

A. Free electrons in the conduction band

B. Neutral migrating dopants

C. Photons emitted by the lattice

D. Holes acting as positive carriers

Answer Key & Full Explanations

1. A — Resistivity is an intrinsic material property independent of an object's dimensions, while resistance depends on length and cross-sectional area. The same material has one resistivity but can form wires of many resistances. Keeping these distinct is frequently tested.

2. D — By the power rule, the derivative of $7x^2$ is $14x$. The exponent multiplies the coefficient and decreases by one. This rule underlies all rate-of-change problems.

3. A — Multiplication of complex numbers is most efficient in polar form: multiply the magnitudes and add the angles. Rectangular form favors addition instead. Choosing the right form avoids extra conversions.

4. A — A single repeated real root produces a critically damped response, the fastest return to steady state without oscillation. Distinct real roots give overdamping and complex roots give underdamped oscillation. Root type determines transient character.

5. B — The median is least affected by an extreme outlier, since it depends only on the middle position, not the magnitude of values. The mean shifts toward outliers. This robustness distinguishes the median.

6. D — The integral of $2x$ is $x^2 + C$, raising the power and dividing by the new exponent. Always include the constant of integration. Integration accumulates quantities such as charge from current.

7. B — The dot product of two perpendicular vectors is zero, since it equals $|A||B|\cos 90° = 0$. This is the definitive orthogonality test. The cross product, by contrast, yields a perpendicular vector.

8. B — The Poisson distribution models the number of discrete events in a fixed interval. It is discrete and suited to counting random occurrences. The normal distribution, by contrast, is continuous.

9. D — The sample standard deviation divides the sum of squared deviations by $N - 1$, correcting for sample bias. The population version divides by N. Misreading which applies changes the answer.

10. A — Expected value is the probability-weighted average: (0.5)(\$1,200) + (0.5)(\$400) = \$600 + \$200 = \$800. Each outcome is weighted by its probability. This underlies economic risk analysis.

11. D — The factor (A/P, i, n) converts a present sum into an equivalent uniform annual payment, reading "find A given P." It is used for loan repayment. Matching factor notation to the conversion is the core skill.

12. B — A benefit-cost ratio of exactly 1.0 means benefits equal costs, the break-even point. Above 1.0 justifies a project and below does not. This threshold is the decision rule.

13. A — When a nominal rate compounds more often than annually, the effective annual rate exceeds the nominal, because interest earns interest within the year. Monthly compounding therefore yields a higher effective rate. Failing to convert understates it.

14. A — An engineer's paramount obligation is to protect public health, safety, and welfare, above employer or client interests. This principle resolves most ethics conflicts. It takes precedence when duties collide.

15. C — A trademark protects a brand name or logo. Patents protect inventions, copyrights protect works of authorship, and trade secrets protect confidential information. Matching IP type to what it protects is the key skill.

16. A — An engineer may seal only work prepared by them or under their direct supervision, so they must refuse to seal unsupervised work. Sealing it would be a serious violation. This rule preserves accountability.

17. D — Accepting undisclosed pay from two parties for the same work violates the duty to act as a faithful agent. Disclosure and consent are required. The other options uphold ethical duties.

18. A — The majority carriers in an n-type semiconductor are free electrons, contributed by donor doping. P-type material has holes as majority carriers. Carrier type governs junction behavior.

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

20. C — Permittivity governs a capacitor's charge storage, since capacitance depends directly on the dielectric's permittivity. Higher permittivity yields greater capacitance. Dielectric choice is key in capacitor design.

21. D — Carrier movement driven by a concentration gradient is diffusion, independent of any applied field. Drift, by contrast, is driven by an electric field. Both contribute to semiconductor current.

22. C — Kirchhoff's Current Law expresses conservation of charge: current entering a node equals current leaving. KVL conserves energy around a loop instead. KCL is the basis of nodal analysis.

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

24. B — For a sinusoid, the RMS value is peak times 0.707 (peak divided by $\sqrt{2}$). RMS is the equivalent DC value delivering the same power. Power calculations always use RMS.

25. D — An inductor's impedance is $j\omega L$, a positive imaginary quantity that increases with frequency. A capacitor's is negative imaginary and a resistor's is real. This frequency dependence underlies filtering.

26. B — 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.

27. C — 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.

28. B — Poles are the values of s that make a transfer function's denominator zero, driving the response toward infinity. Zeros are numerator roots. Pole locations determine stability.

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

30. C — 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.

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

32. A — A common-collector (emitter-follower) amplifier has near-unity voltage gain and is used for buffering and impedance matching. The common-emitter stage gives high voltage gain instead. The follower isolates a source from a load.

33. D — 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 enables clean KCL analysis at the inputs.

34. A — 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.

35. B — Real power, actually consumed as useful work, is measured in watts. Reactive power is in VAR and apparent power in VA. Only resistance consumes real power.

36. B — 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.

37. D — 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.

38. B — 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.

39. B — 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.

40. D — Faraday's law states that an induced voltage arises from a changing magnetic flux. A static field induces nothing. This principle underlies transformers, generators, and inductors.

41. D — 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.

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

43. D — 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.

44. C — 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.

45. 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.

46. C — Frequency modulation varies the carrier's frequency in proportion to the message, while amplitude stays constant. AM and PM vary amplitude and phase instead. FM resists noise better but needs more bandwidth.

47. A — 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.

48. 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.

49. B — 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.

50. C — 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.

51. C — 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.

52. A — 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.

53. D — 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.

54. C — A race condition arises when a circuit's outcome depends on the relative timing of signals meant to be simultaneous, producing unpredictable behavior. It stems from differing path delays, not logic errors. Synchronous design is the standard defense.

55. A — 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.

56. A — 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.

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

58. A — 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.

59. C — 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.

60. B — 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.

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

62. B — 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.

63. D — 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.

64. A — 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.

65. B — 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.

66. D — 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.

67. 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.

68. C — Two's complement is standard for signed numbers because ordinary addition hardware then performs subtraction correctly, and there is a single representation of zero. This simplifies processor design. It is the dominant signed-number convention.

69. 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.

70. B — Binary search requires the data to be sorted in order, because it works by repeatedly halving a sorted range. It achieves O(log n) efficiency but only on ordered data. This precondition is a common exam point.

71. C — 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.

72. 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.

73. 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.

74. C — 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.

75. B — For independent events, the probability that both occur is the product: $0.5 \times 0.4 = 0.20$. Independence permits simple multiplication. Recognizing independence sets the rule.

76. D — 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.

77. D — 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.

78. 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.

79. B — 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.

80. C — 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.

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

82. B — 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.

83. A — 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.

84. C — 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.

85. 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.

86. D — 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.

87. D — The TCP/IP model defines four layers: Link, Internet, Transport, and Application. The OSI model uses seven. TCP/IP is the practical internet model.

88. C — 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.

89. D — A Zener diode regulates voltage by operating in reverse breakdown, where it holds a nearly constant voltage. Standard diodes conduct in forward bias. This controlled breakdown provides regulation.

90. B — 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.

91. C — Expected value is found by weighting each outcome by its probability and summing. Using only the largest or most optimistic outcome ignores the distribution. This links probability to economic risk analysis.

92. B — Binary 10100 equals 16 + 0 + 4 + 0 + 0 = 20 in decimal. Summing the set bits' place values gives the value. Base conversion is a routine skill.

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

94. A — 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.

95. D — 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.

96. C — Code Division Multiplexing lets signals share frequency and time, distinguished by unique codes assigned to each. The receiver uses the code to extract its signal. This is the basis of certain cellular technologies.

97. A — The time constant is $\tau = RC = 2000 \times 5 \times 10^{-6} = 0.01$ s = 10 ms. After one time constant the response completes about 63% of its change. This governs RC transients.

98. C — 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.

99. C — In a purely inductive element, voltage leads current by 90°, captured by the "ELI" portion of ELI the ICE man. A capacitor does the opposite. This phase relationship defines reactive elements.

100. D — A 16-bit address bus addresses $2^{16} = 65{,}536$ distinct locations. The address bus width sets the maximum addressable memory. Each added line doubles the reach.

101. D — Declining a job outside one's expertise reflects the duty to practice only within one's area of competence. Accepting it to maximize billable work would violate that duty. Competence protects public safety.

102. 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.

103. A — A 16 kHz sampling rate can faithfully represent frequencies up to half that, the Nyquist limit: 8 kHz. Components above this would alias. Half the sampling rate is the maximum recoverable frequency.

104. A — 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.

105. D — Hex 0x3C equals 3×16 + 12 = 48 + 12 = 60 in decimal, where C is 12. Each hex digit is weighted by a power of 16. Hex-to-decimal conversion is a routine skill.

106. B — 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.

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

108. C — Three-phase real power is $P = \sqrt{3} \times V_{line} \times I_{line} \times \cos\theta = 1.732 \times 208 \times 6 \times 1.0 \approx 2{,}160$ W. The $\sqrt{3}$ factor is the signature of three-phase calculations. Unity power factor means all apparent power is real.

109. 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 solved simultaneously.

110. D — 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.