PRACTICE EXAM 10: FE ELECTRICAL AND COMPUTER SIMULATION (110 QUESTIONS)

Time allotted: 5 hours 20 minutes

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

1. What is the derivative of $f(x) = x^4$?

A. $4x^3$

B. x^3

C. $4x^5$

D. $3x^4$

2. Evaluate $\int \cos(x)\, dx$.

A. $-\sin(x) + C$

B. $\cos(x) + C$

C. $\sin(x) + C$

D. $-\cos(x) + C$

3. The complex conjugate of $2 - j5$ is:

A. $-2 - j5$

B. $2 + j5$

C. −2 + j5

D. 5 − j2

4. Evaluate the limit lim(x→∞) (5x + 3)/(x + 1).

A. 3

B. 0

C. ∞

D. 5

5. Solve the equation 4^x = 64.

A. 3

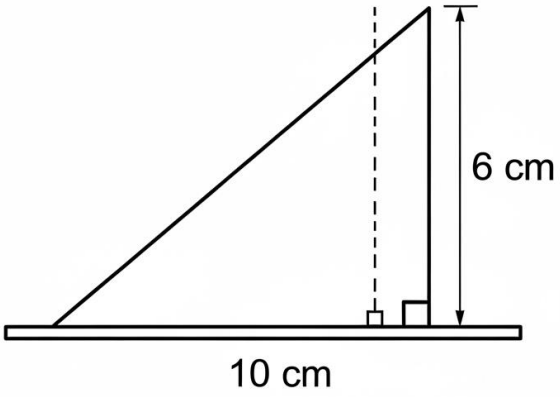
B. 16

C. 4

D. 2

6. For the triangle shown, what is its area?

Figure PQ-1



A. 60 cm²

B. 16 cm²

C. 30 cm²

D. 32 cm²

7. The derivative of a constant function f(x) = 7 is:

A. 7

B. 7x

C. 1

D. 0

8. Evaluate the definite integral $\int_0^2 4\,dx$.

A. 4

B. 2

C. 8

D. 16

9. The trigonometric identity $\sin(2\theta)$ is equivalent to:

A. $2\sin(\theta)$

B. $\sin^2(\theta) - \cos^2(\theta)$

C. $2\sin(\theta)\cos(\theta)$

D. $1 - 2\sin^2(\theta)$

10. The slope of the line $y = -3x + 7$ is:

A. -3

B. 7

C. 3

D. -7

11. Matrix multiplication is generally:

A. Always commutative for square matrices

B. Defined only for diagonal matrices

C. Equivalent to element-wise multiplication

D. Not commutative ($AB \neq BA$ in general)

12. The integral $\int x^{(-1/2)}\, dx$ (for $x > 0$) equals:

A. $(1/2)x^{(1/2)} + C$

B. $2x^{(1/2)} + C$

C. $-2x^{(-3/2)} + C$

D. x^(1/2) + C

13. A spinner is divided into 8 equal sections numbered 1 to 8. What is the probability of landing on a number divisible by 4?

A. 1/8

B. 1/2

C. 1/4

D. 3/8

14. The variance of a data set is 25. What is its standard deviation?

A. 5

B. 625

C. 12.5

D. 25

15. If two events are independent, the probability that both occur equals:

A. The sum of their individual probabilities

B. The larger of the two probabilities

C. Zero in all cases

D. The product of their individual probabilities

16. A class has 12 boys and 8 girls. What fraction of the class is girls?

A. 1/2

B. 2/5

C. 3/5

D. 1/8

17. In how many distinct orders can 4 people line up in a row?

A. 24

B. 12

C. 16

D. 4

18. Under the NSPE Code, an engineer who also sits on a public board reviewing a project on which their firm has bid should:

A. Vote in favor since their firm is well qualified

B. Vote against to appear impartial to observers

C. Disclose the conflict and recuse from the decision

D. Abstain only if another member objects first

19. Under the NSPE Code, engineers shall act for each employer or client as:

A. An advocate maximizing the client's profit alone

B. A neutral party with no particular obligations

C. A representative free to share all client data

D. Faithful agents or trustees

20. An engineer discovers a calculation error in a project already under construction. Under the NSPE Code, the engineer should:

A. Conceal the error to avoid project delays and costs

B. Report the error promptly so it can be corrected

C. Wait to see whether the structure shows distress

D. Quietly revise future documents without disclosure

21. Under the NSPE Code, engineers shall avoid deceptive acts, which includes refraining from:

A. Misrepresenting their qualifications or prior experience

B. Declining work outside their area of competence

C. Charging fees commensurate with the services rendered

D. Disclosing potential conflicts of interest to clients

22. The simple interest earned on $2,000 at 5% per year for 3 years is:

A. $300

B. $100

C. $315

D. $2,300

23. An effective annual interest rate is always:

A. Lower than the nominal rate when compounding occurs

B. Equal to the nominal rate regardless of compounding

C. Greater than or equal to the nominal annual rate

D. Independent of the compounding frequency used

24. A machine is purchased for $30,000 with no salvage value and depreciated straight-line over 5 years. Its book value after 2 years is:

A. $24,000

B. $18,000

C. $12,000

D. $6,000

25. In comparing two mutually exclusive alternatives, an incremental rate-of-return analysis evaluates the:

A. Return earned on the extra investment of the costlier option

B. Total return of each option independently of the other

C. Average of the two options' individual rates of return

D. Ratio of the two options' initial first costs

26. Inflation in an engineering economy analysis causes the purchasing power of future money to:

A. Increase steadily over the analysis period

B. Remain constant regardless of the time horizon

C. Depend only on the nominal interest rate used

D. Decrease over the analysis period

27. The conductivity of a metal generally _____ as its temperature increases.

A. Increases

B. Decreases

C. Remains exactly constant

D. Becomes negative

28. The majority charge carriers in a P-type semiconductor are:

A. Free electrons

B. Negative ions

C. Holes

D. Protons

29. The capacitance of a capacitor depends on the dielectric material through its:

A. Permittivity

B. Conductivity

C. Permeability

D. Resistivity

30. A material that weakly opposes an applied magnetic field, exhibiting a slightly negative susceptibility, is classified as:

A. Ferromagnetic

B. Paramagnetic

C. Ferrimagnetic

D. Diamagnetic

31. A 15 V source is connected across a 3 Ω resistor. What is the current?

A. 45 A

B. 5 A

C. 0.2 A

D. 3 A

32. Three resistors of 2 Ω, 3 Ω, and 5 Ω are connected in series. What is the total resistance?

A. 0.97 Ω

B. 10 Ω

C. 30 Ω

D. 3.3 Ω

33. A capacitor opposes a change in:

A. Voltage across its terminals

B. Current through its terminals

C. Frequency of the source

D. Resistance of the circuit

34. The total power supplied by a source equals the:

A. Voltage divided by the total resistance

B. Difference of the branch powers

C. Largest single resistor's power

D. Sum of the powers dissipated by all elements

35. The reactance of a 2 H inductor at a frequency of 60 Hz is approximately:

A. 120 Ω

B. 377 Ω

C. 754 Ω

D. 0.0013 Ω

36. In nodal analysis, the unknowns being solved for are the:

A. Branch currents in each element

B. Node voltages relative to a reference

C. Mesh currents around each loop

D. Source voltages of the circuit

37. A 10 µF capacitor is connected to a 20 V DC source for a long time. The steady-state current through the capacitor is:

A. 200 µA

B. 2 A

C. 0.5 A

D. 0 A

38. The average value of a full sinusoidal waveform over one complete cycle is:

A. Zero

B. Equal to the peak value

C. 0.637 times the peak

D. 0.707 times the peak

39. Maximum power is transferred from a source with internal resistance R_s to a load resistance R_L when:

A. R_L is much larger than R_s

B. R_L is much smaller than R_s

C. R_L equals R_s

D. R_L is zero (short circuit)

40. A 4 Ω resistor and a 4 Ω inductive reactance are connected in series. The magnitude of the impedance is:

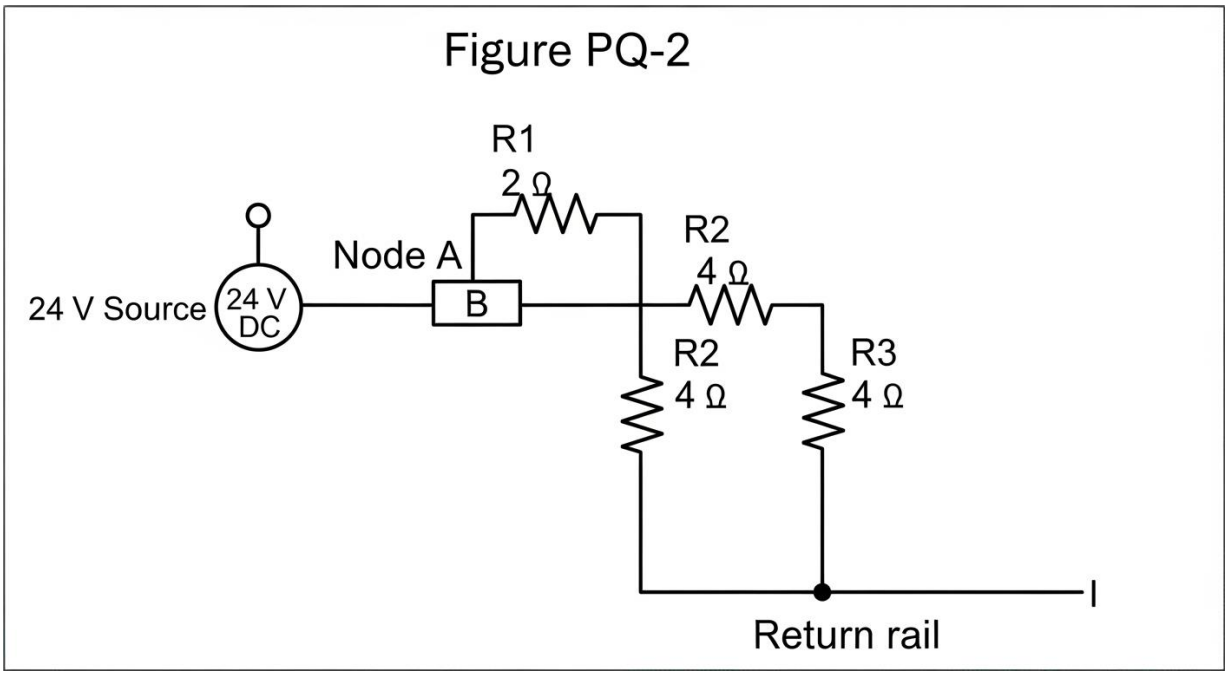
A. 8 Ω

B. 5.66 Ω

C. 0 Ω

D. 4 Ω

41. In the circuit shown, what is the current supplied by the 24 V source?



A. 12 A

B. 4 A

C. 8 A

D. 6 A

42. The unit of electric charge is the:

A. Coulomb

B. Ampere

C. Volt

D. Farad

43. Doubling the voltage across a fixed resistor causes the power dissipated to:

A. Remain the same

B. Double

C. Quadruple

D. Be cut in half

44. The Laplace transform of $\sin(\omega t)\cdot u(t)$ is:

A. $s/(s^2 + \omega^2)$

B. $\omega/(s^2 + \omega^2)$

C. $1/(s + \omega)$

D. $\omega/(s^2 - \omega^2)$

45. The output of an LTI system to a sinusoidal input is a sinusoid of the:

A. Same frequency but with a DC offset added

B. Doubled frequency and the same phase

C. Half frequency and an inverted phase

D. Same frequency with altered amplitude and phase

46. A signal x(t) has finite total energy. Such a signal is classified as a(n):

A. Power signal

B. Periodic signal

C. Energy signal

D. Random signal

47. A transfer function has a zero at s = −2. The system's output is zero when the input is of the form:

A. e^(−2t)

B. e^(+2t)

C. e^(−0.5t)

D. A constant (DC)

48. Decreasing the sampling interval (sampling faster) in a discrete-time system:

A. Increases the risk of aliasing

B. Reduces the risk of aliasing

C. Has no effect on aliasing at all

D. Lowers the Nyquist frequency

49. The frequency at which a system's output power is half its maximum is called the:

A. Resonant frequency

B. Nyquist frequency

C. Center frequency

D. Half-power (−3 dB) frequency

50. A system is BIBO stable if a bounded input always produces a(n):

A. Periodic output of the same period

B. Output that decays to exactly zero

C. Output identical to the input

D. Bounded output

51. In the frequency domain, an ideal high-pass filter passes:

A. All frequencies below the cutoff

B. Only a narrow band around the center frequency

C. All frequencies above the cutoff

D. No frequencies at all

52. A 4 kHz signal is sampled at 10 kHz. Does aliasing occur?

A. Yes, because the rate is below the signal frequency

B. No, because the rate exceeds twice the signal frequency

C. Yes, because the rate is not a multiple of 4 kHz

D. No, because aliasing never occurs in sampling

53. The z-transform is the discrete-time counterpart of the:

A. Fourier series for periodic signals

B. Discrete Fourier transform only

C. Time-domain convolution operation

D. Laplace transform for continuous signals

54. The impulse response completely characterizes a system that is:

A. Linear and time-invariant

B. Nonlinear and time-varying

C. Periodic and bounded

D. Random and memoryless

55. The bandwidth of a signal is a measure of the:

A. Total power contained in the signal

B. Maximum amplitude of the signal

C. Range of frequencies the signal occupies

D. Time duration of one signal period

56. The output impedance of an ideal operational amplifier is:

A. Infinite

B. Zero

C. Equal to the load impedance

D. Equal to the input impedance

57. An op-amp comparator without feedback produces an output that:

A. Saturates to one of the supply rails based on input polarity

B. Tracks the input voltage linearly at all times

C. Equals the difference of the two inputs scaled by ten

D. Remains at zero volts regardless of the inputs

58. In a bipolar junction transistor, the three terminals are the:

A. Gate, source, and drain

B. Anode, cathode, and gate

C. Source, body, and channel

D. Emitter, base, and collector

59. The primary advantage of a MOSFET over a BJT in digital logic is its:

A. Higher base current requirement for switching

B. Very high input impedance and low static power

C. Larger forward voltage drop when conducting

D. Faster minority-carrier recombination time

60. A full-wave bridge rectifier uses how many diodes?

A. 1

B. 2

C. 4

D. 8

61. The function of a filter capacitor following a rectifier in a DC power supply is to:

A. Smooth the pulsating output and reduce ripple

B. Increase the peak output voltage indefinitely

C. Convert the DC back into an AC waveform

D. Provide reverse-polarity protection for the load

62. A transistor operating as a switch in the "on" state is biased into:

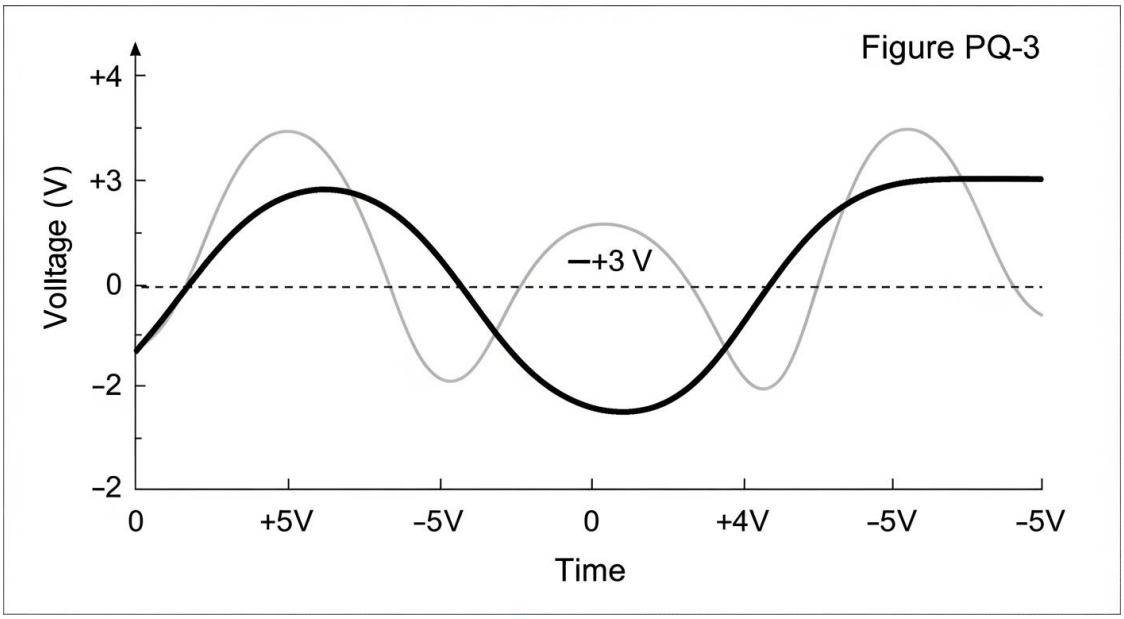
A. The cutoff region

B. The breakdown region

C. The active (linear) region

D. The saturation region

63. The figure shows the output of a circuit when a sinusoid is applied. What circuit function does this output waveform indicate?



A. Half-wave rectification of the input

B. Positive clipping (limiting) of the input

C. Full-wave rectification of the input

D. Amplification of the input by a factor of three

64. A resistive heater draws 8 A from a 120 V supply. What is its power consumption?

A. 15 W

B. 128 W

C. 960 W

D. 480 W

65. A step-up transformer increases voltage and correspondingly:

A. Increases both the voltage and the current

B. Keeps the current the same as the primary

C. Increases the total power delivered to the load

D. Decreases the current proportionally

66. The frequency of the AC supply in North America is:

A. 60 Hz

B. 50 Hz

C. 120 Hz

D. 400 Hz

67. A 12-pole, 60 Hz synchronous generator has a synchronous speed of:

A. 1800 rpm

B. 900 rpm

C. 600 rpm

D. 360 rpm

68. The power loss in a transmission line conductor due to its resistance is called:

A. Dielectric loss

B. I^2R (copper) loss

C. Hysteresis loss

D. Eddy-current loss

69. A load with a leading power factor draws a current that:

A. Lags the voltage in phase

B. Is exactly in phase with the voltage

C. Has zero reactive component

D. Leads the voltage in phase

70. The apparent power delivered to a single-phase load is the product of the:

A. RMS voltage and the RMS current

B. Peak voltage and the average current

C. Real power and the power factor

D. Reactive power and the phase angle

71. A three-phase, 480 V system delivers 50 kVA. The magnitude of the line current is approximately:

A. 104 A

B. 35 A

C. 60 A

D. 150 A

72. An induction motor running at no load draws a current that is primarily:

A. In phase with the supply voltage

B. Magnetizing (lagging, reactive) in nature

C. Leading the supply voltage

D. Equal to the full-load current

73. A current-carrying conductor placed in a magnetic field experiences a force described by:

A. $F = BIL$ (for a conductor perpendicular to the field)

B. $F = q/B$ at all conductor orientations

C. $F = IR^2$ in a uniform magnetic field

D. $F = V^2/B$ for any conductor length

74. The unit of magnetic flux is the:

A. Tesla

B. Henry

C. Ampere-turn

D. Weber

75. The electric flux density D and electric field intensity E in a linear dielectric are related by:

A. $D = E/\varepsilon$

B. $D = \varepsilon E$

C. $D = E^2$

D. $D = \varepsilon/E$

76. As the frequency of an electromagnetic wave increases, its wavelength in free space:

A. Increases proportionally

B. Remains constant

C. Decreases proportionally

D. First increases, then decreases

77. The block-diagram reduction of a simple negative-feedback loop with forward gain G and feedback H gives a closed-loop transfer function of:

A. $G/(1 + GH)$

B. $G/(1 - GH)$

C. $GH/(1 + G)$

D. $(1 + GH)/G$

78. A controller that combines proportional, integral, and derivative actions is known as a:

A. Lead-lag compensator

B. Bang-bang controller

C. State-feedback regulator

D. PID controller

79. The dominant poles of a system are those that:

A. Lie farthest from the imaginary axis

B. Have the largest negative real parts

C. Lie closest to the imaginary axis

D. Are located in the right-half plane

80. The rise time of a system's step response is a measure of how quickly the output:

A. Returns to zero after a disturbance

B. Initially climbs toward its final value

C. Settles within a tolerance band

D. Reaches its maximum overshoot peak

81. The transfer function of a first-order system is $K/(\tau s + 1)$. The parameter τ represents the:

A. Time constant of the system

B. Steady-state gain of the system

C. Natural frequency of oscillation

D. Damping ratio of the response

82. Negative feedback in an amplifier generally:

A. Increases the gain and decreases bandwidth

B. Increases both gain and distortion

C. Reduces stability and increases noise

D. Reduces gain but improves bandwidth and stability

83. A system is said to be controllable if it is possible to:

A. Measure all of its internal states from the output

B. Predict its output for any future input

C. Drive its state to any desired value using the input

D. Maintain a constant output despite disturbances

84. The carrier signal in a communication system is typically a:

A. Random noise waveform

B. High-frequency sinusoid

C. Low-frequency square pulse

D. DC voltage level

85. Single-sideband (SSB) modulation is more bandwidth-efficient than conventional AM because it:

A. Transmits only one sideband and suppresses the carrier

B. Doubles the number of sidebands transmitted

C. Increases the carrier power substantially

D. Adds a second carrier at a higher frequency

86. The signal-to-noise ratio (SNR) of a communication channel is usually expressed in:

A. Hertz

B. Watts

C. Decibels

D. Volts per meter

87. Channel coding (forward error correction) improves communication reliability by:

A. Reducing the transmitted data rate to zero

B. Removing all noise from the channel entirely

C. Increasing the carrier frequency of the signal

D. Adding redundancy that lets the receiver correct errors

88. The bit rate of a digital system that transmits 4 bits per symbol at 2,000 symbols per second is:

A. 500 bps

B. 8,000 bps

C. 2,000 bps

D. 4,000 bps

89. The protocol responsible for reliably delivering a stream of bytes with retransmission of lost segments is:

A. TCP

B. UDP

C. IP

D. ICMP

90. A firewall in a computer network is used primarily to:

A. Increase the data transmission speed

B. Convert analog signals to digital form

C. Control and filter incoming and outgoing traffic

D. Assign IP addresses to new devices

91. In an IPv4 address, how many bits are there in total?

A. 8

B. 16

C. 64

D. 32

92. A switch operating at the data link layer forwards frames based on the destination:

A. IP address

B. MAC address

C. Port number

D. Domain name

93. Convert the decimal number 12 to binary.

A. 1100

B. 1010

C. 1110

D. 1001

94. The Boolean identity A · 1 evaluates to:

A. 1

B. 0

C. A

D. A'

95. The truth table shown defines a two-input logic gate. Which gate does it represent?

	A	B	Output
1	0	0	1
2	0	1	1
3	1 A	0 B	1
4	1 1 B	1 B	0

A. AND gate

B. NAND gate

C. OR gate

D. XOR gate

96. A decoder performs the operation of:

A. Combining many input lines into fewer output lines

B. Storing a single bit of information

C. Adding two binary numbers together

D. Activating one output line for each input code

97. The maximum decimal value representable by an 8-bit unsigned binary number is:

A. 255

B. 256

C. 128

D. 127

98. A flip-flop is a basic memory element capable of storing:

A. One full byte of data

B. An analog voltage level

C. One bit of data

D. A complete instruction word

99. The number of rows in the complete truth table of a 3-input logic function is:

A. 6

B. 8

C. 3

D. 9

100. A combinational logic circuit's output depends on:

A. The previous output state stored internally

B. The clock edge applied to the circuit

C. The order in which inputs were applied

D. Only the present values of its inputs

101. Converting the binary number 101.1 to decimal gives:

A. 5.5

B. 5.1

C. 6.5

D. 4.5

102. The main memory type that loses its contents when power is removed is called:

A. ROM (read-only memory)

B. Flash memory

C. RAM (volatile memory)

D. A magnetic hard disk

103. An operating system's primary role is to:

A. Compile high-level source code into binaries

B. Manage hardware resources and run programs

C. Encrypt all data stored on the disk drive

D. Provide the physical interconnect between chips

104. In a pipelined CPU, beginning a new instruction before the previous one completes increases:

A. The clock period of each stage

B. The number of pipeline stages required

C. The latency of a single instruction

D. The overall instruction throughput

105. The smallest addressable unit of memory in most modern computer systems is the:

A. Bit

B. Word

C. Byte

D. Block

106. A 64-bit processor can directly address a theoretical memory space of:

A. 2^{64} addresses

B. 64 addresses

C. 2×64 addresses

D. 64^2 addresses

107. The time complexity of a lookup in a balanced binary search tree (average case) is:

A. O(n)

B. O(1)

C. $O(n^2)$

D. O(log n)

108. In programming, an "array" is a data structure that stores:

A. A single value of one data type

B. A fixed-size collection of elements of the same type

C. Key-value pairs with unique keys

D. A hierarchy of parent and child nodes

109. A "loop" in a program is used to:

A. Permanently terminate program execution

B. Define a reusable named block of code

C. Repeat a block of code multiple times

D. Allocate memory on the program stack

110. In an if-else control structure, the else block executes when the:

A. Program first starts running

B. If condition evaluates to true

C. Loop counter reaches its maximum

D. If condition evaluates to false

PRACTICE EXAM 10 — ANSWER KEY AND FULL ANSWER EXPLANATIONS

1. A — The power rule gives d/dx[x^4] = $4x^3$, multiplying by the exponent and reducing the power by one. This applies to any constant power of x.

2. C — The integral of cos(x) is sin(x) + C, since the derivative of sin(x) is cos(x). The constant of integration accounts for the family of antiderivatives.

3. B — The complex conjugate negates only the imaginary part, turning 2 − j5 into 2 + j5. Conjugation reflects the number across the real axis.

4. D — For a rational function with equal-degree numerator and denominator, the limit at infinity is the ratio of leading coefficients: 5/1 = 5. Lower-order terms become negligible as x grows.

5. A — Since $4^3 = 64$, the solution is x = 3. Expressing both sides as powers of 4 lets the exponents be equated.

6. C — Triangle area is ½ × base × height = ½ × 10 × 6 = 30 cm^2. The perpendicular height is used regardless of the triangle's slant.

7. D — The derivative of any constant is zero, because a constant function has no rate of change. Its graph is a horizontal line with zero slope.

8. C — The integral of a constant is the constant times the interval width: 4 × (2 − 0) = 8. This equals the area of the rectangle under the line.

9. C — The double-angle identity gives sin(2θ) = 2sin(θ)cos(θ). It is derived from the sine addition formula with both angles equal.

10. A — In slope-intercept form y = mx + b, the coefficient of x is the slope, here −3. The negative sign indicates a line falling from left to right.

11. D — Matrix multiplication is not commutative in general, so AB and BA usually differ and may not even have the same dimensions. Order of multiplication matters.

12. B — Applying the power rule, ∫x^(−1/2) dx = x^(1/2)/(1/2) = 2x^(1/2) + C. The exponent increases by one and divides the term.

13. C — The numbers divisible by 4 are 4 and 8, giving 2 of 8 outcomes, or 1/4. Each section is equally likely.

14. A — Standard deviation is the square root of the variance: √25 = 5. It expresses spread in the data's original units.

15. D — For independent events, the joint probability is the product of the individual probabilities. Independence means one event's occurrence does not affect the other.

16. B — Girls number 8 out of 20 total students, which reduces to 2/5. The fraction compares the subset to the whole class.

17. A — Four people can be arranged in 4! = 24 distinct orders. Each position is filled by one fewer remaining choice.

18. C — A conflict between a public duty and a private firm interest must be disclosed, and the engineer should recuse from the decision. Transparency and recusal preserve the integrity of the public process.

19. D — The NSPE Code requires engineers to act as faithful agents or trustees for each employer or client. This fiduciary duty governs the handling of the client's interests and information.

20. B — A discovered error must be reported promptly so it can be corrected before it causes harm. Concealing or delaying disclosure endangers the public and violates the Code.

21. A — Avoiding deceptive acts includes not misrepresenting one's qualifications or prior experience. Honesty about competence protects clients and the public.

22. A — Simple interest is $P \times r \times t = 2{,}000 \times 0.05 \times 3 = \$300$. It is computed only on the original principal, not on accumulated interest.

23. C — The effective annual rate is greater than the nominal rate whenever compounding occurs more than once a year, and equal only with annual compounding. More frequent compounding increases the true yield.

24. B — Annual depreciation is 30,000/5 = \$6,000, so after two years \$12,000 is depreciated, leaving a book value of \$18,000. Straight-line depreciation removes equal amounts each year.

25. A — Incremental rate-of-return analysis examines the return earned on the additional investment required by the more expensive alternative. It determines whether spending more is justified.

26. D — Inflation erodes the purchasing power of money over time, so future dollars buy less. Economic analyses adjust for this with real (inflation-corrected) rates.

27. B — A metal's conductivity decreases as temperature rises, because increased lattice vibration scatters conduction electrons more. This corresponds to its positive temperature coefficient of resistance.

28. C — In P-type material, holes are the majority carriers, created by trivalent acceptor dopants. The few thermally generated electrons are the minority carriers.

29. A — Capacitance is proportional to the dielectric's permittivity, which measures how readily the material polarizes. A higher-permittivity dielectric stores more charge at a given voltage.

30. D — A diamagnetic material weakly opposes an applied field and has a small negative susceptibility. It is repelled slightly from magnetic fields.

31. B — By Ohm's law, $I = V/R = 15/3 = 5$ A. Current is voltage divided by resistance.

32. B — Series resistances add directly: $2 + 3 + 5 = 10\ \Omega$. The same current passes through each element.

33. A — A capacitor opposes sudden changes in the voltage across it, since its current depends on the rate of voltage change. This is why capacitor voltage cannot change instantaneously.

34. D — By conservation of energy, the total source power equals the sum of the powers dissipated by all circuit elements. No power is created or lost in an ideal circuit.

35. C — Inductive reactance is $X_L = 2\pi fL = 2\pi \times 60 \times 2 \approx 754\ \Omega$. Reactance rises with both frequency and inductance.

36. B — Nodal analysis solves for the node voltages relative to a chosen reference node. Kirchhoff's current law is written at each node in terms of these voltages.

37. D — Once fully charged in DC steady state, a capacitor blocks current, so the steady-state current is zero. The capacitor behaves as an open circuit to DC.

38. A — The average value of a complete sinusoidal cycle is zero, because the positive and negative halves cancel. A nonzero average appears only over a half-cycle.

39. C — Maximum power transfer to a resistive load occurs when the load resistance equals the source's internal resistance. At this match, half the source power reaches the load.

40. B — Impedance magnitude is $\sqrt{(R^2 + X^2)} = \sqrt{(4^2 + 4^2)} = \sqrt{32} \approx 5.66\ \Omega$. The resistance and reactance combine as perpendicular components.

41. D — The two parallel 4 Ω resistors give 2 Ω, adding to the 2 Ω series resistor for 4 Ω total, so $I = 24/4 = 6$ A. Parallel branches combine before the series element.

42. A — The coulomb is the SI unit of electric charge. One coulomb equals the charge transported by one ampere in one second.

43. C — Power is V^2/R, so doubling the voltage quadruples the power. The quadratic dependence makes power very sensitive to voltage.

44. B — The Laplace transform of $\sin(\omega t)\cdot u(t)$ is $\omega/(s^2 + \omega^2)$. The ω in the numerator distinguishes it from the cosine transform.

45. D — An LTI system passes a sinusoid at the same frequency but scales its amplitude and shifts its phase. This frequency-preserving property defines the system's frequency response.

46. C — A signal with finite total energy is an energy signal, typically transient and decaying. Persistent signals with infinite energy but finite average power are power signals instead.

47. A — A zero at s = −2 makes the system's response vanish for an input of the form e^(−2t). Zeros block the corresponding modes from appearing at the output.

48. B — Sampling faster raises the Nyquist frequency, so more of the signal's spectrum fits below it, reducing the chance of aliasing. Higher sample rates better preserve high-frequency content.

49. D — The half-power frequency, where output power is half its maximum, is the −3 dB point. It marks the edge of a filter's passband.

50. D — BIBO stability means every bounded input yields a bounded output. The output never grows without limit for any limited input.

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

52. B — The sampling rate of 10 kHz exceeds twice the 4 kHz signal frequency (8 kHz), so the Nyquist criterion is met and no aliasing occurs. Adequate sampling preserves the signal.

53. D — The z-transform is the discrete-time analog of the Laplace transform, mapping sequences to a complex variable z. It is the primary tool for analyzing discrete systems.

54. A — The impulse response fully characterizes a linear time-invariant system, since any input can be expressed through convolution with it. This property is unique to LTI systems.

55. C — Bandwidth measures the range of frequencies a signal occupies. A wider bandwidth carries more rapidly varying information.

56. B — An ideal op-amp has zero output impedance, allowing it to drive any load without voltage drop. This lets the output voltage be set solely by the feedback network.

57. A — Without feedback, an op-amp comparator drives its output to one supply rail or the other depending on which input is larger. The huge open-loop gain forces this saturation.

58. D — A bipolar junction transistor has emitter, base, and collector terminals. These correspond to its three doped regions.

59. B — A MOSFET's insulated gate gives very high input impedance and draws negligible static current, making it ideal for low-power digital logic. This efficiency underlies modern CMOS technology.

60. C — A full-wave bridge rectifier uses four diodes arranged so that both halves of the AC cycle produce the same output polarity. This doubles the ripple frequency relative to a half-wave design.

61. A — A filter capacitor stores charge during voltage peaks and releases it during dips, smoothing the rectified output and reducing ripple. Larger capacitance yields smaller ripple.

62. D — A transistor switch in the "on" state operates in saturation, where it conducts heavily with a small voltage drop. The "off" state corresponds to cutoff.

63. B — The output follows the input but is flattened at +3 V on its positive peaks, the signature of a positive clipper (limiter). A clipping circuit caps the signal at a set level.

64. C — Power is $P = V \times I = 120 \times 8 = 960$ W for a resistive load. Voltage times current gives the real power consumed.

65. D — A step-up transformer raises voltage while lowering current proportionally, conserving power. The volt-ampere product stays essentially constant in an ideal transformer.

66. A — The standard AC supply frequency in North America is 60 Hz. Much of the rest of the world uses 50 Hz.

67. C — Synchronous speed is $120f/P = 120 \times 60/12 = 600$ rpm. Increasing the pole count lowers the speed for a fixed frequency.

68. B — Resistive loss in a transmission conductor is the I^2R or copper loss, dissipated as heat. Higher transmission voltage reduces current and thus this loss.

69. D — A leading power factor means the current leads the voltage, characteristic of a net capacitive load. The reactive current arrives ahead of the voltage waveform.

70. A — Apparent power for a single-phase load is the product of RMS voltage and RMS current, expressed in volt-amperes. It represents the total power including the reactive component.

71. C — Line current is $I = S/(\sqrt{3} \times V\_LL) = 50{,}000/(1.732 \times 480) \approx 60$ A. The $\sqrt{3}$ factor relates three-phase apparent power to line quantities.

72. B — At no load an induction motor draws mainly magnetizing current to establish the air-gap flux, which is largely reactive and lagging. Little real power is needed without a mechanical load.

73. A — The force on a current-carrying conductor perpendicular to a magnetic field is $F = BIL$. It depends on flux density, current, and conductor length.

74. D — The weber is the SI unit of magnetic flux. One weber corresponds to one volt-second of induced EMF.

75. B — In a linear dielectric, $D = \varepsilon E$, relating electric flux density to field intensity through the permittivity. This constitutive relation underlies capacitor and field analysis.

76. C — Since $\lambda = c/f$, increasing frequency decreases wavelength proportionally in free space. The product of frequency and wavelength stays equal to the speed of light.

77. A — A negative-feedback loop with forward gain G and feedback H has closed-loop gain $G/(1 + GH)$. The feedback term in the denominator reduces and stabilizes the gain.

78. D — A controller combining proportional, integral, and derivative actions is a PID controller. Each term addresses present error, accumulated error, and error rate respectively.

79. C — Dominant poles lie closest to the imaginary axis and decay most slowly, so they govern the system's overall response. Faster poles farther left contribute only brief transients.

80. B — Rise time measures how quickly the step response initially climbs toward its final value. A shorter rise time indicates a faster-responding system.

81. A — In $K/(\tau s + 1)$, the parameter τ is the time constant, setting how fast the first-order system responds. The output reaches about 63% of its final value in one time constant.

82. D — Negative feedback trades reduced gain for wider bandwidth, improved stability, and lower distortion. This trade-off is fundamental to practical amplifier design.

83. C — A system is controllable if a suitable input can drive its internal state to any desired value in finite time. Controllability is essential for full state-feedback design.

84. B — The carrier is typically a high-frequency sinusoid that the lower-frequency message modulates. Its high frequency enables efficient transmission and antenna sizing.

85. A — SSB transmits only one sideband and suppresses the carrier, halving the bandwidth and saving power compared with conventional AM. Both sidebands carry the same information, so one suffices.

86. C — Signal-to-noise ratio is conventionally expressed in decibels, a logarithmic measure of the power ratio. Decibels conveniently compress the wide range of practical ratios.

87. D — Forward error correction adds controlled redundancy so the receiver can detect and correct a limited number of errors without retransmission. This improves reliability over noisy channels.

88. B — Bit rate is bits per symbol times symbol rate: $4 \times 2{,}000 = 8{,}000$ bps. Higher-order symbols carry more bits per transmitted unit.

89. A — TCP provides a reliable byte stream with sequencing and retransmission of lost segments. Its acknowledgment mechanism guarantees ordered delivery.

90. C — A firewall controls and filters network traffic according to security rules, blocking unauthorized access. It enforces a boundary between trusted and untrusted networks.

91. D — An IPv4 address is 32 bits long, usually written as four 8-bit octets. This limits the total IPv4 address space to about 4.3 billion addresses.

92. B — A data-link-layer switch forwards frames based on the destination MAC address. It learns which port reaches each MAC to direct traffic efficiently.

93. A — Decimal 12 = 8 + 4 = 1100 in binary. Summing the corresponding powers of two confirms the conversion.

94. C — The Boolean identity $A \cdot 1 = A$, since ANDing with logic 1 leaves the variable unchanged. The 1 acts as the identity element for AND.

95. B — The output is 1 for every input except when both inputs are 1, which is the defining behavior of a NAND gate. It is the logical inverse of the AND function.

96. D — A decoder activates exactly one output line for each unique combination of its input code. It converts a binary code into a one-of-many selection.

97. A — An 8-bit unsigned number ranges from 0 to $2^8 - 1 = 255$. The maximum is one less than the total count of representable values.

98. C — A flip-flop stores a single bit of binary information. Multiple flip-flops are combined to store larger words.

99. B — A 3-input function has $2^3 = 8$ possible input combinations, giving 8 truth-table rows. Each added input doubles the number of rows.

100. D — A combinational circuit's output depends only on the present input values, with no memory of past states. This distinguishes it from sequential logic.

101. A — Binary 101.1 equals 4 + 0 + 1 + 0.5 = 5.5 in decimal. The digit after the point carries a weight of 2^{-1}.

102. C — RAM is volatile memory that loses its contents when power is removed. ROM and flash, by contrast, retain data without power.

103. B — An operating system manages hardware resources and provides an environment for running programs. It mediates between applications and the underlying hardware.

104. D — Pipelining overlaps the execution of successive instructions, increasing overall instruction throughput. It does not shorten any single instruction's latency.

105. C — In most modern systems the byte is the smallest individually addressable unit of memory. Individual bits are accessed only through operations on bytes.

106. A — A 64-bit address bus can reference 2^{64} distinct memory locations. Each added address bit doubles the addressable space.

107. D — A lookup in a balanced binary search tree takes O(log n) time, since each comparison halves the search space. Balancing keeps the tree height logarithmic.

108. B — An array stores a fixed-size, ordered collection of elements that share the same data type. Elements are accessed directly by their index.

109. C — A loop repeats a block of code multiple times, either a set number of times or while a condition holds. It avoids duplicating the same statements.

110. D — In an if-else structure, the else block runs when the if condition evaluates to false. It provides the alternative path of execution.