OJEE M Tech Electronics Sample Paper 03

A) Mode and Time: The exam is a Computer Based Test (CBT) lasting 120 minutes.
B) Total Questions: The exam contains 90 questions.
C) Marking Scheme & Rules:

- +4 for correct answers and -1 for incorrect responses.

Q1. In a p-n junction diode at room temperature, an increase in the reverse bias voltage from 1V to 5V will:

A. Increase the reverse saturation current significantly

B. Decrease the reverse saturation current

C. Have almost no effect on the reverse saturation current

D. Cause Zener breakdown

Q2. The effective mass of an electron in a semiconductor is inversely proportional to the:

A. First derivative of energy with respect to wave vector (dE/dk)

B. Second derivative of energy with respect to wave vector (d^2E/dk^2)

C. Bandgap energy

D. Temperature

Q3. In a common-base configuration, the current gain (α) is typically:

A. Greater than 100

B. Exactly 1

C. Slightly less than 1

D. Zero

Q4. The threshold voltage of an enhancement-mode n-channel MOSFET can be reduced by:

A. Increasing the channel length

B. Increasing the oxide thickness

C. Decreasing the substrate doping concentration

D. Increasing the source-to-body voltage

Q5. Which of the following feedback topologies decreases both input and output impedances?

A. Voltage-series (Series-Shunt)

B. Voltage-shunt (Shunt-Shunt)

C. Current-series (Series-Series)

D. Current-shunt (Shunt-Series)

Q6. The maximum theoretical efficiency of a Class A transformer-coupled power amplifier is:

A. 25%

B. 50%

C. 78.5%

D. 100%

Q7. An op-amp is configured as an inverting amplifier with $R_{in} = 1$ kΩ and $R_f = 10$ kΩ. The input voltage is 2V. The output voltage is:

A. 20 V

B. -20 V

C. 22 V

D. -22 V

Q8. The 555 timer operates as a monostable multivibrator when connected with:

A. Two resistors and one capacitor

B. One resistor and one capacitor

C. Only resistors

D. No external components

Q9. A Wien bridge oscillator uses both positive and negative feedback. At the resonant frequency, the net phase shift around the loop is:

A. 0 degrees

B. 90 degrees

C. 180 degrees

D. 270 degrees

Q10. The dual of the Boolean expression $X + YZ$ is:

A. $X(Y + Z)$

B. $X + Y + Z$

C. $\overline{X} + \overline{YZ}$

D. $X(Y \cdot Z)$

Q11. How many 2-input NAND gates are required to implement a 2-input XOR gate?

A. 3

B. 4

C. 5

D. 6

Q12. A demultiplexer can also be used as:

A. An encoder

B. A multiplexer

C. A decoder

D. A shift register

Q13. In a D flip-flop, if the D input changes during the clock pulse (while the clock is active), the output will:

A. Change immediately

B. Change on the next clock edge

C. Become metastable

D. Toggle

Q14. A memory system with 16 address lines and 8 data lines has a storage capacity of:

A. 16 KB

B. 32 KB

C. 64 KB

D. 128 KB

Q15. In the 8085 microprocessor, the Program Counter (PC) is a:

A. 8-bit register

B. 16-bit register

C. 32-bit register

D. General purpose register

Q16. The period of the discrete-time signal $x[n] = \cos(\pi n/4)$ is:

A. 4

B. 8

C. $\pi/4$

D. Not periodic

Q17. The Fourier series representation of a real, even, and periodic signal contains only:

A. Sine terms

B. Cosine terms

C. Both sine and cosine terms

D. Odd harmonics

Q18. The system characterized by the impulse response $h(t) = e^{2t}u(t)$ is:

A. Stable and causal

B. Stable and non-causal

C. Unstable and causal

D. Unstable and non-causal

Q19. The z-transform of $a^n u[n]$ has a region of convergence (ROC) given by:

A. $|z| > |a|$

B. $|z| < |a|$

C. $|z| = |a|$

D. Entire z-plane

Q20. In a unity feedback control system, if the open-loop transfer function has 1 pole at the origin, the system is:

A. Type 0

B. Type 1

C. Type 2

D. Type 3

Q21. The break-away point in a root locus plot is always a solution to the equation:

A. $1 + G(s)H(s) = 0$

B. $dK/ds = 0$

C. $G(s)H(s) = \infty$

D. $dG/ds = 0$

Q22. A second-order system has a damping ratio $\zeta = 0.5$. The system is:

A. Undamped

B. Underdamped

C. Critically damped

D. Overdamped

Q23. In a Bode plot, a phase margin of positive degrees implies that the closed-loop system is:

A. Stable

B. Unstable

C. Marginally stable

D. Non-minimum phase

Q24. State-space representation of a system is:

A. Unique for a given system

B. Not unique for a given system

C. Only applicable to linear systems

D. Only applicable to time-invariant systems

Q25. In an AM wave, if the carrier voltage is 10V and the maximum amplitude of the AM wave is 15V, the modulation index is:

A. 0.5

B. 1.0

C. 1.5

D. 0.25

Q26. Which modulation scheme is most resilient to amplitude noise?

A. AM

B. DSB-SC

C. FM

D. VSB

Q27. The intermediate frequency (IF) commonly used in standard AM radio receivers is:

A. 10.7 MHz

B. 455 kHz

C. 38 kHz

D. 1 MHz

Q28. According to Nyquist's sampling theorem, a signal with maximum frequency f_m must be sampled at a rate f_s such that:

A. $f_s = f_m$

B. $f_s \geq 2f_m$

C. $f_s < 2f_m$

D. $f_s = 1.5f_m$

Q29. In a PCM system, if the number of bits per sample is increased from 8 to 9, the signal-to-quantization noise ratio (SQNR) improves by approximately:

A. 3 dB

B. 6 dB

C. 9 dB

D. 12 dB

Q30. Maxwell's equation $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$ is derived from:

A. Gauss's law

B. Ampere's law

C. Faraday's law

D. Biot-Savart law

Q31. The standing wave ratio (SWR) on a perfectly matched transmission line is:

A. 0

B. 1

C. -1

D. Infinity

Q32. When an electromagnetic wave travels from a dielectric medium to a perfect conductor, the reflection coefficient is:

A. 1

B. -1

C. 0

D. 0.5

Q33. In a rectangular waveguide, which mode is referred to as the dominant mode (assuming $a > b$)?

A. TE01

B. TE11

C. TE10

D. TM11

Q34. An isolator in microwave engineering is a:

A. 2-port reciprocal device

B. 2-port non-reciprocal device

C. 3-port reciprocal device

D. 4-port non-reciprocal device

Q35. A magnetron is primarily used as an:

A. Amplifier

B. Oscillator

C. Isolator

D. Phase shifter

Q36. A microstrip line consists of:

A. Two parallel conducting strips

B. A conducting strip separated from a ground plane by a dielectric substrate

C. A hollow rectangular pipe

D. Two coaxial conductors

Q37. Kirchhoff's Current Law (KCL) is based on the principle of conservation of:

A. Energy

B. Momentum

C. Charge

D. Mass

Q38. The time constant of an RL circuit is given by:

A. R/L

B. L/R

C. RL

D. $1/(RL)$

Q39. In a two-port network, the hybrid parameter h_{11} is defined as:

A. V_1/I_1 with $V_2 = 0$

B. V_1/V_2 with $I_1 = 0$

C. I_2/I_1 with $V_2 = 0$

D. I_2/V_2 with $I_1 = 0$

Q40. Two coupled coils have self-inductances $L_1 = 4$ mH and $L_2 = 9$ mH. The maximum possible mutual inductance is:

A. 6 mH

B. 13 mH

C. 36 mH

D. 5 mH

Q41. In a highly doped n-type semiconductor, the Fermi level moves closer to the:

A. Valence band

B. Conduction band

C. Intrinsic Fermi level

D. Vacuum level

Q42. A Zener diode is primarily designed to operate in the:

A. Forward biased region

B. Reverse breakdown region

C. Active region

D. Cut-off region

Q43. In a common-emitter amplifier, adding an unbypassed emitter resistor R_E results in:

A. Increased voltage gain

B. Decreased input impedance

C. Increased bandwidth and stability

D. Increased output distortion

Q44. The efficiency of a full-wave rectifier is theoretically maximum at:

A. 40.6%

B. 81.2%

C. 100%

D. 50%

Q45. The conversion time of a Successive Approximation Register (SAR) ADC for an n-bit conversion requires:

A. 2^n clock cycles

B. n clock cycles

C. 1 clock cycle

D. n^2 clock cycles

Q46. A multiplexer with 4 select lines can have up to how many data inputs?

A. 4

B. 8

C. 16

D. 32

Q47. Which type of flip-flop is typically used to eliminate race-around condition?

A. D flip-flop

B. Master-Slave J-K flip-flop

C. T flip-flop

D. S-R flip-flop

Q48. In 8085 assembly language, the instruction 'CMP B' performs:

A. Addition of A and B

B. Subtraction of B from A without storing the result

C. Copying B to A

D. Comparing B with C

Q49. The discrete-time Fourier transform (DTFT) of a sequence is always:

A. Continuous and periodic

B. Discrete and periodic

C. Continuous and aperiodic

D. Discrete and aperiodic

Q50. An IIR digital filter is typically derived from an analog filter prototype using the:

A. Windowing technique

B. Frequency sampling method

C. Bilinear transformation

D. Inverse DFT

Q51. In a control system, adding a zero to the open-loop transfer function has the effect of:

A. Moving the root locus to the right

B. Decreasing relative stability

C. Increasing the steady-state error

D. Improving the transient response and stability

Q52. The gain margin is positive if the gain crossover frequency is:

A. Greater than the phase crossover frequency

B. Less than the phase crossover frequency

C. Equal to the phase crossover frequency

D. Infinity

Q53. In FM, the Carson's bandwidth B_T for a signal with frequency deviation 75 kHz and modulating frequency 15 kHz is:

A. 90 kHz

B. 150 kHz

C. 180 kHz

D. 210 kHz

Q54. The probability of error for coherent BPSK is equal to:

A. $Q(\sqrt{E_b/N_0})$

B. $Q(\sqrt{2E_b/N_0})$

C. $\frac{1}{2}e^{-E_b/N_0}$

D. $Q(E_b/N_0)$

Q55. A transmission line is considered distortionless if its primary constants satisfy:

A. $R/L = G/C$

B. $R = G = 0$

C. $RC = LG$

D. $L/C = R/G$

Q56. The directivity of an isotropic antenna is:

A. 0 dBi

B. 1.64 dBi

C. 2.15 dBi

D. 3 dBi

Q57. Which semiconductor device exhibits a negative resistance region and is used in microwave oscillators?

A. Zener diode

B. Varactor diode

C. Tunnel diode

D. Schottky diode

Q58. The operational amplifier integrator circuit is sensitive to:

A. High frequency noise

B. DC offset voltage drift

C. Common mode signals

D. Output saturation due to AC inputs

Q59. Which among the following is a non-volatile memory?

A. SRAM

B. DRAM

C. Cache Memory

D. EEPROM

Q60. In the context of antennas, the VSWR is 1.5. The corresponding reflection coefficient $|\Gamma|$ is:

A. 0.1

B. 0.2

C. 0.5

D. 0.8

Q61. For a $n \times n$ matrix A, if $|A| \neq 0$, then the rank of A is:

A. n

B. $n - 1$

C. 1

D. Zero

Q62. The system of linear equations $AX = B$ has infinitely many solutions if:

A. Rank(A) = Rank(A—B) = n

B. Rank(A) $\neq$ Rank(A—B)

C. Rank(A) = Rank(A—B) $< n$

D. Rank(A) $> n$

Q63. The limit $\lim_{x\to 0} \frac{1-\cos(2x)}{x^2}$ evaluates to:

A. 0

B. 1

C. 2

D. 4

Q64. The Taylor series expansion of e^x around $x = 0$ is:

A. $1 - x + x^2/2! - \ldots$

B. $1 + x + x^2/2! + x^3/3! + \ldots$

C. $x - x^3/3! + x^5/5! - \ldots$

D. $1 + x^2/2! + x^4/4! + \ldots$

Q65. The double integral $\int_0^1 \int_0^x xy \, dy \, dx$ is equal to:

A. 1/8

B. 1/4

C. 1/6

D. 1/2

Q66. The divergence of the vector field $\mathbf{V} = x^2\mathbf{i} + y^2\mathbf{j} + z^2\mathbf{k}$ is:

A. $x + y + z$

B. $2x + 2y + 2z$

C. $x^2 + y^2 + z^2$

D. 0

Q67. The differential equation $y'' - 5y' + 6y = 0$ has the general solution:

A. $C_1e^{2x} + C_2e^{3x}$

B. $C_1e^{-2x} + C_2e^{-3x}$

C. $C_1e^x + C_2e^{6x}$

D. $(C_1 + C_2x)e^{3x}$

Q68. If $z = x + iy$, the imaginary part of $\sin(z)$ is:

A. $\sin(x)\cosh(y)$

B. $\cos(x)\sinh(y)$

C. $\sin(x)\sinh(y)$

D. $\cos(x)\cosh(y)$

Q69. The Cauchy-Riemann equations for a complex function $f(z) = u(x, y) + iv(x, y)$ in polar coordinates (r, θ) are:

A. $u_r = \frac{1}{r}v_\theta$ and $v_r = -\frac{1}{r}u_\theta$

B. $u_r = v_\theta$ and $v_r = -u_\theta$

C. $u_r = -rv_\theta$ and $v_r = ru_\theta$

D. $u_\theta = rv_r$ and $v_\theta = -ru_r$

Q70. Two dice are thrown. The probability of getting a sum of 7 is:

A. 1/36

B. 1/12

C. 1/6

D. 1/9

Q71. If A and B are independent events, then $P(A \cap B)$ is equal to:

A. $P(A) + P(B)$

B. $P(A|B)P(B)$

C. $P(A)P(B)$

D. 0

Q72. For a binomial distribution with $n = 10$ and $p = 0.4$, the mean and variance are respectively:

A. 4 and 2.4

B. 4 and 4

C. 0.4 and 0.24

D. 2.4 and 4

Q73. In the bisection method, if roots lie between a and b, the first approximation x_1 is:

A. $(a+b)/2$

B. $\sqrt{ab}$

C. $a-b$

D. $(a-b)/2$

Q74. The order of convergence of the Secant method is approximately:

A. 1.000

B. 1.618

C. 2.000

D. 3.000

Q75. Laplace transform of $f(t) = \sin(\omega t)$ is:

A. $\frac{s}{s^2+\omega^2}$

B. $\frac{\omega}{s^2+\omega^2}$

C. $\frac{s}{s^2-\omega^2}$

D. $\frac{\omega}{s^2-\omega^2}$

Q76. The rank of the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{bmatrix}$ is:

A. 1

B. 2

C. 3

D. 0

Q77. The integral $\int \ln(x)\, dx$ evaluates to:

A. $1/x + C$

B. $x\ln(x) - x + C$

C. $x\ln(x) + x + C$

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

Q78. The solution of the partial differential equation $\frac{\partial z}{\partial x} = 0$ is:

A. $z = f(x)$

B. $z = f(y)$

C. $z = c$

D. $z = x + y$

Q79. If X is an exponentially distributed random variable with parameter $\lambda = 2$, its expected value $E[X]$ is:

A. 2

B. 1

C. 0.5

D. 0.25

Q80. Euler's method to solve $y' = f(x, y)$ with step size h uses the formula $y_{n+1} =$

A. $y_n + hf(x_n, y_n)$

B. $y_n - hf(x_n, y_n)$

C. $y_n + hf'(x_n, y_n)$

D. $y_n + h^2 f(x_n, y_n)$

Q81. Find the missing term: 2, 6, 12, 20, ..., 42.

A. 28

B. 30

C. 32

D. 36

Q82. In a certain code, 'ROAST' is coded as 'PMYQR'. How is 'SLOPPY' coded?

A. QJMNNW

B. QKNNNW

C. QJMNMV

D. RJNNNW

Q83. Pointing to a woman, a man says, 'She is the only daughter of my father's wife.' How is the woman related to the man?

A. Sister

B. Daughter

C. Aunt

D. Wife

Q84. A girl walks 30m towards South, then turns right and walks 30m. Then turning left, she walks 20m. Again she turns left and walks 30m. How far is she from her starting position?

A. 30 m

B. 50 m

C. 60 m

D. 80 m

Q85. Statements: I. All pencils are pens. II. No pen is a book. Conclusions: I. No pencil is a book. II. Some pens are pencils.

A. Only conclusion I follows

B. Only conclusion II follows

C. Both conclusions I and II follow

D. Neither conclusion follows

Q86. Five people A, B, C, D, and E are sitting in a row facing North. E is at the extreme left end. A is to the immediate left of B. C is to the immediate right of D. D is to the immediate right of B. Who is sitting exactly in the middle?

A. A

B. B

C. C

D. D

Q87. What is the angle between the hands of a clock at 4:20?

A. 0 degrees

B. 10 degrees

C. 15 degrees

D. 20 degrees

Q88. If today is Thursday, what day will it be after 65 days?

A. Friday

B. Saturday

C. Sunday

D. Monday

Q89. In a class of 60 students, the ratio of boys to girls is 2:1. Rohit's rank is 15th from the top. If there are 8 girls ahead of Rohit, how many boys are after him in rank?

A. 30

B. 31

C. 32

D. 33

Q90. Choose the odd one out:

A. Square

B. Rectangle

C. Triangle

D. Cube

Solutions

1. C
Explanation: Reverse saturation current (I_0) is practically independent of the reverse bias voltage and depends primarily on temperature.

2. B
Explanation: Effective mass $m^* = \hbar^2/(\frac{d^2E}{dk^2})$. It is inversely proportional to the curvature of the E-k diagram.

3. C
Explanation: In a CB amplifier, $\alpha = I_C/I_E$. Since I_C is slightly less than I_E due to base recombination, α is typically 0.98 to 0.995.

4. C
Explanation: Threshold voltage V_T decreases if the bulk charge decreases, which occurs when substrate doping (N_A) is reduced.

5. B
Explanation: Voltage-shunt feedback (Shunt-Shunt) samples voltage (decreases output impedance) and mixes in shunt (decreases input impedance).

6. B
Explanation: A transformer-coupled Class A amplifier eliminates DC power loss in the load, achieving a theoretical maximum efficiency of 50%.

7. B
Explanation: The closed-loop gain is $A_v = -R_f/R_{in} = -10$. Output voltage $V_o = A_v \times V_{in} = -10 \times 2 = -20$V.

8. B
Explanation: In monostable mode, the 555 timer requires one external resistor (R) and one capacitor (C) to set the pulse width $T = 1.1RC$.

9. A
Explanation: For sustained oscillations (Barkhausen criterion), the total phase shift around the loop must be $0°$ or $360°$.

10. A
Explanation: To find the dual, replace AND with OR, OR with AND, and keep variables as they are: $X \cdot (Y + Z)$.

11. B
Explanation: A standard optimal implementation of a 2-input XOR gate requires exactly 4 NAND gates.

12. C
Explanation: A demultiplexer with its data input tied to a logic HIGH functions exactly as a binary decoder.

13. B
Explanation: Assuming an edge-triggered D flip-flop, it samples the data only at the specific active clock edge. Changes during the level are ignored.

14. C
Explanation: 2^{16} address locations = 65536 locations. Each location is 8 bits (1

byte). Thus, total capacity is 64 KB.

15. B
Explanation: The PC holds the 16-bit memory address of the next instruction to be fetched, hence it is a 16-bit register.

16. B
Explanation: The angular frequency is $\omega = \pi/4$. Period $N = 2\pi m/\omega = 2\pi m/(\pi/4) = 8m$. For $m = 1$, fundamental period $N = 8$.

17. B
Explanation: An even function has no sine components (which are odd) in its Fourier series, leaving only cosine terms and possibly a DC component.

18. C
Explanation: It is causal because $h(t) = 0$ for $t < 0$. It is unstable because $\int_0^\infty |e^{2t}|dt = \infty$ (not absolutely integrable).

19. A
Explanation: The infinite sum $\sum(az^{-1})^n$ converges when $|az^{-1}| < 1$, which translates to $|z| > |a|$.

20. B
Explanation: The 'Type' of a system is defined by the number of open-loop poles located exactly at the origin ($s = 0$).

21. B
Explanation: The break-away or break-in points occur where the multiple roots of the characteristic equation exist, found by setting $dK/ds = 0$.

22. B
Explanation: For $0 < \zeta < 1$, the system is underdamped and exhibits an oscillatory transient response.

23. A
Explanation: A positive phase margin (and positive gain margin) indicates that the Nyquist plot does not encircle $(-1, 0)$, implying stability for minimum phase systems.

24. B
Explanation: A system can have infinitely many valid state-space representations depending on the choice of state variables (through similarity transformations).

25. A
Explanation: Maximum amplitude $V_{max} = V_c(1 + m) \implies 15 = 10(1 + m) \implies 1 + m = 1.5 \implies m = 0.5$.

26. C
Explanation: FM (Frequency Modulation) contains information in its frequency variations. An amplitude limiter can remove amplitude noise without affecting the signal.

27. B
Explanation: In standard AM broadcasting superheterodyne receivers, the IF is universally chosen around 455 kHz.

28. B
Explanation: The sampling theorem dictates that $f_s \geq 2f_m$ to avoid aliasing and allow perfect reconstruction.

29. B
Explanation: In PCM, SQNR $\approx 1.76 + 6.02n$ dB. Increasing n by 1 bit improves the SQNR by approximately 6 dB.

30. C
Explanation: This is the differential form of Faraday's law of electromagnetic induction.

31. B
Explanation: For a matched line, reflection coefficient $\Gamma = 0$. SWR $= (1 + |\Gamma|)/(1 - |\Gamma|) = 1/1 = 1$.

32. B
Explanation: For a perfect conductor, intrinsic impedance $\eta_2 = 0$. $\Gamma = (\eta_2 - \eta_1)/(\eta_2 + \eta_1) = (0 - \eta_1)/(0 + \eta_1) = -1$.

33. C
Explanation: The mode with the lowest cutoff frequency in a rectangular waveguide where width a is greater than height b is the TE_{10} mode.

34. B
Explanation: An isolator allows microwave energy to pass in one direction but absorbs energy traveling in the reverse direction, making it non-reciprocal.

35. B
Explanation: The magnetron is a crossed-field tube that operates inherently as a high-power microwave oscillator, commonly used in radars and microwaves.

36. B
Explanation: A microstrip is a type of planar transmission line consisting of a conductor on one side of a dielectric substrate and a single ground plane on the other.

37. C
Explanation: KCL states that the sum of currents entering a node is zero, which is a direct consequence of the conservation of electric charge.

38. B
Explanation: For a series RL circuit, the time constant τ, which indicates how fast the current reaches its steady state, is L/R seconds.

39. A
Explanation: The h-parameter equations are $V_1 = h_{11}I_1 + h_{12}V_2$. Setting $V_2 = 0$ (short circuit) gives $h_{11} = V_1/I_1$, which is the input impedance.

40. A
Explanation: Mutual inductance $M = k\sqrt{L_1 L_2}$. Maximum M occurs when coupling coefficient $k = 1$. $M_{max} = \sqrt{4 \times 9} = \sqrt{36} = 6$ mH.

41. B
Explanation: Adding donor impurities (n-type doping) increases electron concentration, which shifts the Fermi level up towards the conduction band edge.

42. B
Explanation: A Zener diode is heavily doped so it can operate continuously in reverse breakdown without damage, providing voltage regulation.

43. C
Explanation: An unbypassed R_E introduces negative series feedback, which reduces voltage gain but improves input impedance, bandwidth, and bias stability.

44. B
Explanation: The maximum theoretical efficiency (ratio of DC power out to AC power in) of a full-wave rectifier is $8/\pi^2 \approx 81.2\%$.

45. B
Explanation: A SAR ADC determines one bit per clock cycle, starting from the MSB to the LSB, thus taking exactly n clock cycles.

46. C
Explanation: A multiplexer with n select lines can handle up to 2^n input lines. For $n = 4$, it is $2^4 = 16$ inputs.

47. B
Explanation: The Master-Slave configuration isolates the output from the inputs during the active clock level, preventing toggling multiple times (race-around).

48. B
Explanation: The 'CMP' instruction subtracts the operand from the Accumulator to set the flags, but discards the result, leaving A unchanged.

49. A
Explanation: The DTFT maps a discrete sequence to a continuous function of frequency ω, which is always periodic with period 2π.

50. C
Explanation: The bilinear transformation converts an analog transfer function $H(s)$ into a digital transfer function $H(z)$ while preserving stability.

51. D
Explanation: Adding a zero pulls the root locus toward the left-half of the s-plane, effectively adding derivative control which improves damping and stability.

52. B
Explanation: For a stable minimum-phase system, the gain crossover frequency (ω_{gc}) must be less than the phase crossover frequency (ω_{pc}).

53. C
Explanation: $B_T = 2(\Delta f + f_m) = 2(75 + 15) = 2(90) = 180$ kHz.

54. B
Explanation: For coherent Binary Phase Shift Keying (BPSK), the bit error rate (BER) in AWGN is exactly $Q(\sqrt{2E_b/N_0})$.

55. C
Explanation: The condition for a distortionless line is $R/L = G/C$, which can be rearranged as $RC = LG$.

56. A

Explanation: An isotropic radiator emits energy equally in all directions, so its directivity is exactly 1, which corresponds to 0 dBi.

57. C
Explanation: Due to quantum mechanical tunneling, a tunnel diode exhibits a region of negative differential resistance, useful in high-frequency oscillators.

58. B
Explanation: An ideal integrator integrates any small DC input offset voltage over time, causing the output to ramp up until the op-amp saturates.

59. D
Explanation: EEPROM retains its stored data even when the power is turned off, unlike SRAM, DRAM, and Cache which are volatile.

60. B
Explanation: $|\Gamma| = (\text{VSWR} - 1)/(\text{VSWR} + 1) = (1.5 - 1)/(1.5 + 1) = 0.5/2.5 = 1/5 = 0.2$.

61. A
Explanation: A non-zero determinant implies that all rows and columns are linearly independent, meaning the matrix has full rank n.

62. C
Explanation: By Rouché-Capelli theorem, consistency requires Rank(A) = Rank(A—B). If this rank is strictly less than the number of unknowns (n), there are infinite solutions.

63. C
Explanation: Using L'Hôpital's rule twice: limit is $\lim_{x\to 0} \frac{2\sin(2x)}{2x} = \lim_{x\to 0} \frac{4\cos(2x)}{2} = \frac{4}{2} = 2$. Alternatively, $1 - \cos(2x) = 2\sin^2(x)$, so $\lim \frac{2\sin^2(x)}{x^2} = 2$.

64. B
Explanation: The Maclaurin series for the exponential function is the sum of $x^n/n!$ for all non-negative integers n.

65. A
Explanation: Inner integral: $\int_0^x xydy = x[y^2/2]_0^x = x^3/2$. Outer integral: $\int_0^1 x^3/2dx = [x^4/8]_0^1 = 1/8$.

66. B
Explanation: Divergence $\nabla \cdot \mathbf{V} = \frac{\partial(x^2)}{\partial x} + \frac{\partial(y^2)}{\partial y} + \frac{\partial(z^2)}{\partial z} = 2x + 2y + 2z$.

67. A
Explanation: Characteristic equation $m^2 - 5m + 6 = 0 \implies (m-2)(m-3) = 0 \implies m = 2, 3$. Solution is $y = C_1e^{2x} + C_2e^{3x}$.

68. B
Explanation: $\sin(x+iy) = \sin(x)\cos(iy) + \cos(x)\sin(iy)$. Since $\cos(iy) = \cosh(y)$ and $\sin(iy) = i\sinh(y)$, the imaginary part is $\cos(x)\sinh(y)$.

69. A
Explanation: In polar form, the C-R equations change to $\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}$ and $\frac{\partial v}{\partial r} = -\frac{1}{r}\frac{\partial u}{\partial \theta}$.

70. C

Explanation: Favorable outcomes for sum of 7: (1,6), (2,5), (3,4), (4,3), (5,2), (6,1). Total favorable = 6. Probability = $6/36 = 1/6$.

71. C
Explanation: By definition, two events are independent if the probability of their intersection is the product of their individual probabilities.

72. A
Explanation: Mean $\mu = np = 10(0.4) = 4$. Variance $\sigma^2 = np(1-p) = 10(0.4)(0.6) = 2.4$.

73. A
Explanation: The bisection method continually halves the interval, so the first estimate is exactly the midpoint $(a+b)/2$.

74. B
Explanation: The Secant method exhibits a superlinear convergence rate equal to the golden ratio, which is approximately 1.618.

75. B
Explanation: By definition and integration, $\mathcal{L}\{\sin(\omega t)\} = \frac{\omega}{s^2+\omega^2}$ for $s > 0$.

76. A
Explanation: Rows 2 and 3 are exact scalar multiples of Row 1 (factors of 2 and 3 respectively). Hence, there is only 1 linearly independent row.

77. B
Explanation: Using integration by parts: $\int 1 \cdot \ln(x)dx = x\ln(x) - \int x(1/x)dx = x\ln(x) - x + C$.

78. B
Explanation: Since the derivative with respect to x is 0, the function z must not contain x, meaning it is purely an arbitrary function of y, $z = f(y)$.

79. C
Explanation: For an exponential distribution with rate parameter λ, the mean is given by $1/\lambda = 1/2 = 0.5$.

80. A
Explanation: Forward Euler method uses the slope at the current point to approximate the next point linearly: $y_{n+1} = y_n + hf(x_n, y_n)$.

81. B
Explanation: The sequence represents $n(n+1)$. $1 \times 2 = 2$, $2 \times 3 = 6$, $3 \times 4 = 12$, $4 \times 5 = 20$. Next is $5 \times 6 = 30$. Check: $6 \times 7 = 42$.

82. A
Explanation: Each letter is shifted backward by 2 positions. S-2=Q, L-2=J, O-2=M, P-2=N, P-2=N, Y-2=W. Hence, QJMNNW.

83. A
Explanation: The man's father's wife is his mother. The only daughter of his mother is his sister.

84. B
Explanation: Path: South 30m. Right(West) 30m. Left(South) 20m. Left(East)

30m. She ends up directly South of start by $30 + 20 = 50$ m.

85. C

Explanation: Since all pencils are inside pens, and pens are completely disjoint from books, no pencil can be a book. Since all pencils are pens, there are some pens that are pencils. Both follow.

86. B

Explanation: E is on the left end. The rest form a chain: A is left of B (AB), D is right of B (ABD), C is right of D (ABDC). Together with E, the arrangement is E A B D C. The middle person is B.

87. B

Explanation: Hour hand angle $= 4(30) + 20(0.5) = 120 + 10 = 130°$. Minute hand angle $= 20(6) = 120°$. Difference $= 130 - 120 = 10°$.

88. B

Explanation: 65 divided by 7 yields a remainder of 2. Two days after Thursday is Saturday.

89. D

Explanation: Total boys $= \frac{2}{3} \times 60 = 40$. Rohit is 15th, so 14 students are ahead. Since 8 are girls, $14 - 8 = 6$ boys are ahead of him. Including Rohit (a boy), $6 + 1 = 7$ boys are counted. Remaining boys $= 40 - 7 = 33$.

90. D

Explanation: Square, Rectangle, and Triangle are 2-dimensional (flat) geometrical figures, whereas a Cube is a 3-dimensional figure.