OJEE M Tech Electronics Sample Paper 01

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. The built-in potential of an abrupt p-n junction depends on:

A. Temperature only

B. Doping concentration only

C. Both temperature and doping concentration

D. Neither temperature nor doping

Q2. As the reverse bias voltage across a step-graded p-n junction increases, the depletion capacitance:

A. Increases linearly

B. Decreases

C. Remains constant

D. Increases exponentially

Q3. The Early effect in a Bipolar Junction Transistor (BJT) is caused by:

A. Avalanche breakdown at the base-collector junction

B. Thermal runaway

C. Base-width modulation

D. High-frequency limitations

Q4. A silicon n-channel enhancement MOSFET has a threshold voltage of 1V. If $V_{GS} = 3V$ and $V_{DS} = 5V$, the device is operating in the:

A. Cut-off region

B. Linear (Triode) region

C. Saturation region

D. Breakdown region

Q5. In a CMOS inverter, the dynamic power dissipation is proportional to:

A. Frequency

B. Square of the frequency

C. Square root of the frequency

D. Independent of frequency

Q6. Which of the following diodes is primarily utilized for voltage regulation?

A. Tunnel diode

B. Zener diode

C. Varactor diode

D. Schottky diode

Q7. For a BJT operating in the active region, the common-emitter current gain β and common-base current gain α are related by:

A. $\beta = \frac{\alpha}{1+\alpha}$

B. $\beta = \frac{\alpha}{1-\alpha}$

C. $\beta = \frac{1-\alpha}{\alpha}$

D. $\beta = \alpha(1 - \alpha)$

Q8. An ideal operational amplifier has:

A. Infinite input impedance and infinite output impedance

B. Zero input impedance and infinite output impedance

C. Infinite input impedance and zero output impedance

D. Zero input impedance and zero output impedance

Q9. The slew rate of an op-amp is defined as the:

A. Maximum rate of change of input voltage

B. Maximum rate of change of output voltage

C. Ratio of differential gain to common-mode gain

D. Bandwidth of the amplifier

Q10. A 555 timer configured as an astable multivibrator has resistors $R_1 = 1$ kΩ, $R_2 = 2$ kΩ, and capacitor $C = 1\mu$F. The duty cycle of the output waveform is:

A. 33.3 per cent

B. 50 per cent

C. 60 per cent

D. 66.7 per cent

Q11. The resolution of a 10-bit Analog-to-Digital Converter (ADC) with a full-scale range of 5V is approximately:

A. 5 mV

B. 4.88 mV

C. 9.76 mV

D. 2.44 mV

Q12. Which ADC architecture provides the fastest conversion time?

A. Successive Approximation Register (SAR)

B. Dual-slope integrating

C. Flash

D. Sigma-Delta

Q13. The Boolean expression $Y = A\overline{B} + \overline{A}B$ represents which logic gate?

A. AND

B. OR

C. XOR

D. XNOR

Q14. The minimum number of 2-to-1 multiplexers required to implement a 2-input AND gate is:

A. 1

B. 2

C. 3

D. 4

Q15. In a J-K flip-flop, if $J = 1$ and $K = 1$, the output on the next clock pulse will:

A. Be set to 1

B. Be reset to 0

C. Remain unchanged

D. Toggle

Q16. How many flip-flops are required to design a modulo-10 (decade) synchronous counter?

A. 3

B. 4

C. 5

D. 10

Q17. In the 8085 microprocessor, which of the following interrupts has the highest priority?

A. INTR

B. RST 7.5

C. RST 6.5

D. TRAP

Q18. The addressing mode of the 8085 instruction 'MOV A, M' is:

A. Direct addressing

B. Immediate addressing

C. Register indirect addressing

D. Implied addressing

Q19. A continuous-time system is described by $y(t) = x(t-2) + x(2-t)$. The system is:

A. Causal and linear

B. Non-causal and linear

C. Causal and non-linear

D. Non-causal and non-linear

Q20. The convolution of a unit step function $u(t)$ with itself is:

A. $u(t)$

B. $t \cdot u(t)$

C. $t^2 \cdot u(t)$

D. $\delta(t)$

Q21. The continuous-time Fourier transform of a Gaussian pulse is:

A. A sinc function

B. A step function

C. An impulse train

D. A Gaussian pulse

Q22. The region of convergence (ROC) of the Z-transform of a causal sequence:

A. Includes the origin

B. Is the interior of a circle

C. Is the exterior of a circle

D. Is the entire Z-plane

Q23. The Laplace transform of $f(t) = te^{-at}u(t)$ is:

A. $\frac{1}{s+a}$

B. $\frac{1}{(s+a)^2}$

C. $\frac{1}{s(s+a)}$

D. $\frac{1}{(s-a)^2}$

Q24. A continuous-time signal is band-limited to 5 kHz. According to the Nyquist theorem, the minimum sampling frequency to perfectly reconstruct the signal is:

A. 2.5 kHz

B. 5 kHz

C. 10 kHz

D. 20 kHz

Q25. For a unity feedback system with open-loop transfer function $G(s) = \frac{10}{s(s+2)}$, the steady-state error for a unit ramp input is:

A. 0

B. 0.2

C. 5

D. Infinity

Q26. According to the Routh-Hurwitz criterion, the polynomial $s^3 + 2s^2 + s + 2 = 0$ has:

A. All roots in the left half s-plane

B. One root in the right half s-plane

C. Roots on the imaginary axis

D. All roots in the right half s-plane

Q27. In a root locus plot, the branches originate from:

A. Open-loop zeros and terminate at open-loop poles

B. Open-loop poles and terminate at open-loop zeros or infinity

C. The origin and terminate at infinity

D. Infinity and terminate at open-loop poles

Q28. In a Bode magnitude plot, a simple pole at origin contributes a slope of:

A. +20 dB/decade

B. -20 dB/decade

C. +40 dB/decade

D. -40 dB/decade

Q29. The gain margin of a system is the reciprocal of the magnitude of the open-loop transfer function evaluated at the:

A. Gain crossover frequency

B. Phase crossover frequency

C. Resonant frequency

D. Cut-off frequency

Q30. The state transition matrix $\Phi(t)$ of a system satisfies:

A. $\Phi(0) = 0$

B. $\Phi(0) = I$

C. $\Phi^{-1}(t) = \Phi(t)$

D. $\Phi(t_1 + t_2) = \Phi(t_1) - \Phi(t_2)$

Q31. An amplitude modulated (AM) signal has a carrier power of 100W and a modulation index of 0.5. The total transmission power is:

A. 100 W

B. 112.5 W

C. 125 W

D. 150 W

Q32. According to Carson's rule, the bandwidth of an FM signal with maximum frequency deviation Δf and modulating frequency f_m is approximately:

A. $2\Delta f$

B. $2f_m$

C. $2(\Delta f + f_m)$

D. $\Delta f + f_m$

Q33. In a superheterodyne receiver with an intermediate frequency (IF) of 455 kHz, tuned to a station at 1000 kHz, the image frequency is:

A. 545 kHz

B. 1455 kHz

C. 1910 kHz

D. 2455 kHz

Q34. In Pulse Code Modulation (PCM), if the number of quantization levels is increased from 8 to 64, the bandwidth requirement:

A. Remains the same

B. Doubles

C. Triples

D. Quadruples

Q35. Which digital modulation scheme provides the lowest probability of error for a given signal-to-noise ratio in an AWGN channel?

A. ASK

B. FSK

C. BPSK

D. DPSK

Q36. According to Shannon's channel capacity theorem, the capacity of a channel with bandwidth B and signal-to-noise ratio S/N is:

A. $C = B\log_2(1 + S/N)$

B. $C = B\log_{10}(1 + S/N)$

C. $C = 2B\log_2(S/N)$

D. $C = B\ln(1 + S/N)$

Q37. Which of Maxwell's equations states that magnetic monopoles do not exist?

A. $\nabla \cdot \mathbf{D} = \rho_v$

B. $\nabla \cdot \mathbf{B} = 0$

C. $\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$

D. $\nabla \times \mathbf{H} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t}$

Q38. The skin depth of an electromagnetic wave in a good conductor:

A. Increases with an increase in frequency

B. Decreases with an increase in frequency

C. Is independent of frequency

D. Increases with an increase in conductivity

Q39. A lossless transmission line has distributed inductance $L = 0.5\mu$H/m and capacitance $C = 200$ pF/m. The characteristic impedance is:

A. 25Ω

B. 50Ω

C. 75Ω

D. 100Ω

Q40. If the reflection coefficient on a transmission line is 0.5, the Voltage Standing Wave Ratio (VSWR) is:

A. 1.5

B. 2.0

C. 3.0

D. 0.5

Q41. For a dominant TE10 mode in a rectangular waveguide of dimensions $a \times b$ (where $a > b$), the cutoff wavelength is:

A. a

B. $2a$

C. b

D. $2b$

Q42. The Z-parameters of a two-port network are $Z_{11} = 40\Omega$, $Z_{12} = 20\Omega$, $Z_{21} = 20\Omega$, and $Z_{22} = 30\Omega$. The network is:

A. Reciprocal but not symmetrical

B. Symmetrical but not reciprocal

C. Both reciprocal and symmetrical

D. Neither reciprocal nor symmetrical

Q43. The maximum power transfer from a source with internal impedance $Z_s = 4 + j3\Omega$ to a load Z_L occurs when Z_L is:

A. $4 + j3\Omega$

B. $4 - j3\Omega$

C. $-4 + j3\Omega$

D. 4Ω

Q44. In a series RLC circuit, the resonant frequency is 1000 rad/s and the bandwidth is 100 rad/s. The quality factor (Q) of the circuit is:

A. 0.1

B. 10

C. 100

D. 1000

Q45. The Superposition theorem is NOT applicable to:

A. Voltage calculations

B. Current calculations

C. Power calculations

D. Linear networks

Q46. Norton's equivalent circuit consists of:

A. A voltage source in series with a resistor

B. A current source in parallel with a resistor

C. A voltage source in parallel with a resistor

D. A current source in series with a resistor

Q47. In intrinsic silicon at room temperature, the Fermi level lies:

A. Near the conduction band

B. Near the valence band

C. Exactly in the middle of the bandgap

D. Inside the conduction band

Q48. Which of the following devices operates on the principle of the transferred-electron effect?

A. IMPATT diode

B. TRAPATT diode

C. Gunn diode

D. PIN diode

Q49. For fabricating a Light Emitting Diode (LED) emitting visible red light, the semiconductor material used should be:

A. Silicon

B. Germanium

C. Gallium Arsenide Phosphide (GaAsP)

D. Indium Antimonide

Q50. An operational amplifier circuit uses a capacitor in the feedback path and a resistor at the input. This circuit functions as an:

A. Integrator

B. Differentiator

C. Inverting amplifier

D. Non-inverting amplifier

Q51. Schmitt trigger is a comparator with:

A. Negative feedback

B. Positive feedback

C. No feedback

D. Infinite gain

Q52. A 4-bit Johnson counter goes through how many distinct states?

A. 4

B. 8

C. 15

D. 16

Q53. The standard TTL logic gate typically has a maximum fan-out of:

A. 2

B. 5

C. 10

D. 50

Q54. Which addressing mode is NOT supported by the 8051 microcontroller?

A. Immediate

B. Direct

C. Register Indirect

D. Memory Indirect

Q55. In signal processing, zero padding of a time-domain signal results in:

A. Increased frequency resolution in the DTFT

B. Interpolation in the frequency domain of the DFT

C. Aliasing in the time domain

D. Convolution in the frequency domain

Q56. A system with transfer function $H(z) = \frac{z}{z-0.5}$ is:

A. FIR and stable

B. IIR and stable

C. IIR and unstable

D. FIR and unstable

Q57. The primary advantage of a Phase-Locked Loop (PLL) in communication systems is:

A. Amplification of weak signals

B. Frequency tracking and demodulation

C. Attenuation of high frequencies

D. Impedance matching

Q58. A half-wave dipole antenna has a directivity of approximately:

A. 1.0

B. 1.5

C. 1.64

D. 2.15

Q59. In microwave engineering, a magic tee is a combination of:

A. Two E-plane tees

B. Two H-plane tees

C. An E-plane tee and an H-plane tee

D. A directional coupler and a circulator

Q60. The transient response of a purely resistive circuit to a step input is:

A. Exponentially decaying

B. Oscillatory

C. Delayed

D. Instantaneous

Q61. The sum and product of the eigenvalues of a 3×3 matrix A are 6 and -12, respectively. If two of the eigenvalues are 2 and 5, the third eigenvalue is:

A. -1

B. -2

C. 1

D. 3

Q62. For a square matrix A, if $A^2 = A$, then the eigenvalues of A can only be:

A. 0 and -1

B. 1 and -1

C. 0 and 1

D. Complex numbers

Q63. The value of $\lim_{x \to 0} \frac{x - \sin(x)}{x^3}$ is:

A. 0

B. 1/6

C. 1/3

D. 1/2

Q64. The function $f(x) = x^3 - 3x^2 + 3x + 7$ has:

A. A local maximum at $x = 1$

B. A local minimum at $x = 1$

C. A point of inflection at $x = 1$

D. No critical points

Q65. The value of the definite integral $\int_{-\pi}^{\pi} \sin^3(x) \cos^2(x) dx$ is:

A. π

B. $\pi/2$

C. 1

D. 0

Q66. The work done by the force $\mathbf{F} = y\mathbf{i} + x\mathbf{j}$ in moving a particle from $(0, 0)$ to $(1, 1)$ along the curve $y = x^2$ is:

A. 0

B. 1/2

C. 1

D. 2

Q67. According to Stokes' theorem, the line integral $\oint_C \mathbf{A} \cdot d\mathbf{r}$ is equal to the surface integral of:

A. $\nabla \cdot \mathbf{A}$

B. $\nabla \times \mathbf{A}$

C. $\nabla \mathbf{A}$

D. $\nabla^2 \mathbf{A}$

Q68. The integrating factor for the linear differential equation $\frac{dy}{dx} + \frac{2}{x}y = x^2$ is:

A. x^2

B. e^x

C. $\ln(x)$

D. $2/x$

Q69. The general solution of the differential equation $\frac{d^2y}{dx^2} + 4y = 0$ is:

A. $C_1 e^{2x} + C_2 e^{-2x}$

B. $C_1 \cos(2x) + C_2 \sin(2x)$

C. $C_1 e^{x} + C_2 e^{-x}$

D. $C_1 + C_2 x$

Q70. The Laplace transform of the unit impulse function $\delta(t)$ is:

A. 0

B. 1

C. $1/s$

D. $1/s^2$

Q71. An analytic function $f(z) = u(x, y) + jv(x, y)$ satisfies the Cauchy-Riemann equations, which are:

A. $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

B. $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$

C. $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial x}$ and $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial y}$

D. $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$ and $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$

Q72. The residue of $f(z) = \frac{1}{(z-1)(z-2)}$ at the pole $z = 1$ is:

A. 1

B. -1

C. 2

D. -2

Q73. The value of the contour integral $\oint_C \frac{dz}{z}$, where C is the unit circle $|z| = 1$ traversed counterclockwise, is:

A. 0

B. πj

C. $2\pi j$

D. $-2\pi j$

Q74. In a Poisson distribution, if the mean is 4, the variance is:

A. 2

B. 4

C. 8

D. 16

Q75. The area under the standard normal probability density function curve from $-\infty$ to $+\infty$ is:

A. 0.5

B. 1

C. π

D. $\sqrt{2\pi}$

Q76. Two fair coins are tossed. Given that at least one is heads, the probability that both are heads is:

A. 1/4

B. 1/3

C. 1/2

D. 2/3

Q77. In numerical analysis, the Newton-Raphson method for finding roots of an equation has a convergence order of:

A. 1 (Linear)

B. 1.618 (Fractional)

C. 2 (Quadratic)

D. 3 (Cubic)

Q78. The error in the Trapezoidal rule of numerical integration is of the order of:

A. h

B. h^2

C. h^3

D. h^4

Q79. The standard fourth-order Runge-Kutta method requires how many function evaluations per step?

A. 2

B. 3

C. 4

D. 5

Q80. If $P(A) = 0.4$, $P(B) = 0.5$, and $P(A \cup B) = 0.7$, then events A and B are:

A. Mutually exclusive

B. Independent

C. Dependent

D. Exhaustive

Q81. Find the next number in the series: 2, 5, 10, 17, 26, ...

A. 35

B. 37

C. 39

D. 41

Q82. Complete the alphabetical series: BDF, HJL, NPR, ...

A. SUW

B. TVX

C. TWY

D. TVZ

Q83. In a certain code, "COMPUTER" is written as "RFUVQNPC". How will "MEDICINE" be written in that code?

A. EOJDJEFM

B. MFEDJJOE

C. MFEJDJOE

D. EOJDEJFM

Q84. Pointing to a photograph of a boy, Suresh said, "He is the son of the only son of my mother." How is Suresh related to that boy?

A. Brother

B. Uncle

C. Cousin

D. Father

Q85. A person walks 10 km North, then turns right and walks 5 km, then turns right again and walks 10 km. How far and in which direction is he from the starting point?

A. 5 km East

B. 5 km West

C. 10 km North

D. 15 km South

Q86. Statements: I. All cats are dogs. II. All dogs are birds. Conclusions: I. All cats are birds. II. Some birds are cats.

A. Only conclusion I follows

B. Only conclusion II follows

C. Both conclusions I and II follow

D. Neither conclusion I nor II follows

Q87. Six friends A, B, C, D, E, and F are sitting in a circle facing the center. A is between B and C. D is between E and F. B is to the immediate right of E. Who is sitting to the immediate left of C?

A. A

B. D

C. F

D. B

Q88. At 3:15, what is the angle between the hour hand and the minute hand of a clock?

A. 0 degrees

B. 7.5 degrees

C. 15 degrees

D. 22.5 degrees

Q89. If January 1st of a non-leap year is a Monday, what day of the week will December 31st of the same year be?

A. Sunday

B. Monday

C. Tuesday

D. Wednesday

Q90. In a class of 50 students, 30 study Physics, 25 study Chemistry, and 10 study neither. How many students study both Physics and Chemistry?

A. 5

B. 10

C. 15

D. 20

Solutions

1. C
Explanation: The built-in potential $V_{bi} = \frac{kT}{q} \ln\left(\frac{N_A N_D}{n_i^2}\right)$. Since n_i is temperature-dependent, V_{bi} depends on both doping concentration and temperature.

2. B
Explanation: Depletion capacitance is inversely proportional to the width of the depletion region, which widens as reverse bias increases. Thus, capacitance decreases.

3. C
Explanation: The Early effect in a BJT refers to base-width modulation, where the effective base width decreases as the reverse-bias collector-base voltage increases.

4. C
Explanation: The MOSFET is in saturation because V_{DS} (5V) $> V_{GS} - V_T$ (3V $-$ 1V $=$ 2V).

5. A
Explanation: Dynamic power dissipation in a CMOS inverter is given by $P = fCV^2$, meaning it is directly proportional to the switching frequency.

6. B
Explanation: Zener diodes are heavily doped p-n junctions designed to operate safely in the reverse breakdown region, providing a constant reference voltage.

7. B
Explanation: The common-emitter current gain β is defined as I_C/I_B, and α is I_C/I_E. Using $I_E = I_B + I_C$, we get $\beta = \frac{\alpha}{1-\alpha}$.

8. C
Explanation: An ideal op-amp draws no input current (infinite input impedance) and can supply any amount of load current without voltage drop (zero output impedance).

9. B
Explanation: Slew rate is the maximum rate of change of the output voltage per unit time, typically measured in V/μs.

10. C
Explanation: The duty cycle for an astable 555 timer is $\frac{R_1+R_2}{R_1+2R_2}$. Here, $\frac{1+2}{1+4} = \frac{3}{5} = 60\%$.

11. B
Explanation: Resolution $= \frac{V_{ref}}{2^n} = \frac{5\text{V}}{1024} = 4.88$ mV.

12. C
Explanation: The Flash ADC uses $2^n - 1$ comparators to perform conversion simultaneously, making it the fastest ADC architecture.

13. C
Explanation: The Boolean expression $Y = A\overline{B} + \overline{A}B$ is the standard sum-of-products form for an Exclusive-OR (XOR) gate.

14. A

Explanation: A single 2-to-1 MUX can implement an AND gate by connecting input A to the select line, B to D_1, and 0 to D_0.

15. D
Explanation: In a J-K flip-flop, the condition $J = 1$ and $K = 1$ forces the output to toggle its state on every clock pulse.

16. B
Explanation: A decade counter has 10 states. Since $2^3 = 8$ is not enough, and $2^4 = 16$ is sufficient, a minimum of 4 flip-flops is required.

17. D
Explanation: TRAP is a non-maskable interrupt in the 8085 microprocessor and has the highest priority among all hardware interrupts.

18. C
Explanation: The `MOV A, M` instruction uses the HL register pair as a pointer to the memory location, which classifies it as register indirect addressing.

19. B
Explanation: The system output at time t depends on input at time $t - 2$ (past) and $2 - t$ (future if $t < 1$), making it non-causal. It satisfies superposition, so it is linear.

20. B
Explanation: The convolution of two unit step functions $u(t) * u(t)$ results in a ramp function $r(t) = t \cdot u(t)$.

21. D
Explanation: A unique property of a Gaussian function is that its Fourier transform is also a Gaussian function.

22. C
Explanation: For a causal sequence, the ROC of the Z-transform extends outward from the outermost pole to infinity, essentially the exterior of a circle.

23. B
Explanation: The Laplace transform of $e^{-at}u(t)$ is $\frac{1}{s+a}$. Multiplying by t in the time domain differentiates the transform in the s-domain, giving $\frac{1}{(s+a)^2}$.

24. C
Explanation: The Nyquist rate is twice the highest frequency component. For a 5 kHz signal, the minimum sampling frequency is 2×5 kHz $= 10$ kHz.

25. B
Explanation: This is a Type-1 system. Velocity error constant $K_v = \lim_{s\to 0} sG(s) = \frac{10}{2} = 5$. Steady-state error for unit ramp is $\frac{1}{K_v} = \frac{1}{5} = 0.2$.

26. C
Explanation: The Routh array for $s^3 + 2s^2 + s + 2 = 0$ yields a row of zeros. The auxiliary equation is $2s^2 + 2 = 0$, giving roots at $\pm j$, which lie on the imaginary axis.

27. B
Explanation: Root locus branches start at the open-loop poles ($K = 0$) and terminate at the open-loop zeros ($K = \infty$).

28. B
Explanation: A simple pole at the origin, representing $1/s$ or an integrator, has a constant magnitude slope of -20 dB/decade.

29. B
Explanation: Gain margin is calculated at the phase crossover frequency, where the phase angle is exactly -180 degrees.

30. B
Explanation: The state transition matrix evaluated at $t = 0$ yields the identity matrix, representing the initial state mapping to itself.

31. B
Explanation: Total power $P_t = P_c\left(1 + \frac{m^2}{2}\right)$. $P_t = 100 \times \left(1 + \frac{0.5^2}{2}\right) = 100 \times (1 + 0.125) = 112.5$ W.

32. C
Explanation: Carson's bandwidth rule for FM is $BW = 2(\Delta f + f_m)$, accommodating both peak frequency deviation and highest modulating frequency.

33. C
Explanation: Image frequency $f_{si} = f_s + 2IF$. $f_{si} = 1000 + 2(455) = 1000 + 910 = 1910$ kHz.

34. B
Explanation: Bits per sample n increases from 3 ($2^3 = 8$) to 6 ($2^6 = 64$). Since PCM bandwidth is proportional to n, the bandwidth doubles.

35. C
Explanation: BPSK utilizes antipodal signaling (180° phase shift), which maximizes the distance between signal points, providing the lowest bit error rate in AWGN.

36. A
Explanation: Shannon-Hartley theorem defines channel capacity $C = B\log_2(1 + S/N)$ bits per second.

37. B
Explanation: Gauss's law for magnetism, $\nabla \cdot \mathbf{B} = 0$, implies that there are no net magnetic sources or sinks, meaning magnetic monopoles do not exist.

38. B
Explanation: Skin depth is inversely proportional to the square root of frequency, conductivity, and permeability. Thus, it decreases as frequency increases.

39. B
Explanation: Characteristic impedance $Z_0 = \sqrt{L/C} = \sqrt{0.5 \times 10^{-6}/200 \times 10^{-12}} = \sqrt{2500} = 50\ \Omega$.

40. C
Explanation: VSWR $= \frac{1+|\Gamma|}{1-|\Gamma|} = \frac{1+0.5}{1-0.5} = \frac{1.5}{0.5} = 3.0$.

41. B
Explanation: For the dominant TE10 mode in a rectangular waveguide, the cutoff wavelength $\lambda_c = \frac{2a}{m}$ for $m = 1$, yielding $\lambda_c = 2a$.

42. A
Explanation: Since $Z_{12} = Z_{21}$, the network is reciprocal. Since $Z_{11} \neq Z_{22}$, the network is not symmetrical.

43. B
Explanation: Maximum power transfer occurs when the load impedance is the complex conjugate of the source impedance ($Z_L = Z_s^*$).

44. B
Explanation: The quality factor Q is the ratio of resonant frequency to bandwidth. $Q = \frac{\omega_0}{BW} = \frac{1000}{100} = 10$.

45. C
Explanation: Superposition applies only to linear responses like voltage and current. Power is a non-linear (quadratic) function of V and I.

46. B
Explanation: Norton's theorem states any linear bilateral network can be reduced to a single current source in parallel with an equivalent resistor.

47. C
Explanation: In an intrinsic semiconductor at thermal equilibrium, the Fermi level sits roughly in the middle of the forbidden bandgap.

48. C
Explanation: The Gunn diode is a transferred-electron device that exhibits negative differential resistance at high frequencies due to inter-valley electron transfer.

49. C
Explanation: GaAsP is a direct bandgap semiconductor suitable for emitting visible red light depending on its composition ratio.

50. A
Explanation: An op-amp with an input resistor and a feedback capacitor integrates the input signal, serving as an ideal integrator.

51. B
Explanation: A Schmitt trigger uses positive feedback to create hysteresis, making it highly immune to noise on the input signal.

52. B
Explanation: An N-bit Johnson counter has $2N$ distinct states. A 4-bit counter has $2 \times 4 = 8$ states.

53. C
Explanation: Standard TTL logic gates typically have a fan-out of 10, meaning they can drive 10 standard TTL inputs without voltage drop issues.

54. D
Explanation: The 8051 microcontroller supports immediate, direct, and register indirect addressing modes, but lacks a memory indirect addressing mode.

55. B
Explanation: Zero-padding a time-domain signal increases the number of points in the DFT, interpolating the frequency-domain spectrum to provide higher apparent resolution.

56. B
Explanation: The transfer function has a single pole at $z = 0.5$. Since the pole lies inside the unit circle ($|z| < 1$), the IIR system is stable.

57. B
Explanation: PLLs are primarily used to synchronize the frequency and phase of a local oscillator to an incoming carrier, essential for demodulation.

58. C
Explanation: The maximum directivity of a theoretical half-wave dipole antenna in free space is approximately 1.64 (or 2.15 dBi).

59. C
Explanation: A magic tee is a 4-port microwave component formed by combining an E-plane (series) tee and an H-plane (shunt) tee.

60. D
Explanation: Purely resistive circuits have no energy storage elements (like L or C), so the response to a step input tracks the input instantaneously.

61. A
Explanation: The sum of eigenvalues equals the trace. If $\lambda_1 = 2$, $\lambda_2 = 5$, and sum=6, then $2 + 5 + \lambda_3 = 6$, meaning $\lambda_3 = -1$.

62. C
Explanation: If $A^2 = A$, the matrix is idempotent. The eigenvalues must satisfy $\lambda^2 = \lambda$, so λ can only be 0 or 1.

63. B
Explanation: Using Maclaurin expansion of $\sin(x) = x - x^3/3! + \ldots$, the expression becomes $\frac{x-(x-x^3/6)}{x^3} = \frac{1}{6}$.

64. C
Explanation: $f'(x) = 3x^2 - 6x + 3 = 3(x-1)^2$. $f'(1) = 0$. $f''(x) = 6x - 6$. $f''(1) = 0$. Since the derivative doesn't change sign, $x = 1$ is a point of inflection.

65. D
Explanation: The integrand $\sin^3(x)\cos^2(x)$ is an odd function. The integral of an odd function over a symmetric interval $[-\pi, \pi]$ is exactly 0.

66. C
Explanation: Substitute $y = x^2$ and $dy = 2xdx$. The integral becomes $\int_0^1 (x^2 dx + x(2x)dx) = \int_0^1 3x^2 dx = x^3\big|_0^1 = 1$.

67. B
Explanation: Stokes' theorem equates the line integral of a vector field over a closed loop to the surface integral of its curl ($\nabla \times \mathbf{A}$) over the enclosed surface.

68. A
Explanation: The integrating factor is $e^{\int P(x)dx} = e^{\int (2/x)dx} = e^{2\ln x} = x^2$.

69. B
Explanation: The characteristic equation $m^2 + 4 = 0$ has roots $m = \pm 2j$. This leads to a sinusoidal complementary solution $C_1\cos(2x) + C_2\sin(2x)$.

70. B

Explanation: The Laplace transform of the Dirac delta impulse function $\delta(t)$ is defined as exactly 1.

71. A
Explanation: For a complex function to be analytic, it must satisfy the Cauchy-Riemann equations: $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$, and $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$.

72. B
Explanation: The residue at simple pole $z = 1$ is found by evaluating $(z-1)f(z)$ at $z = 1$, which yields $\frac{1}{1-2} = -1$.

73. C
Explanation: By Cauchy's Integral Formula, integral of $f(z)/z\ dz$ around a contour enclosing origin is $2\pi j f(0)$. Here $f(z) = 1$, so the result is $2\pi j$.

74. B
Explanation: In a Poisson probability distribution, one of the defining characteristics is that both the mean and the variance are equal ($\lambda = 4$).

75. B
Explanation: The total area under any valid probability density function curve from negative to positive infinity must equal 1.

76. B
Explanation: Sample space of two coins: {HH, HT, TH, TT}. Given at least one head, the space reduces to {HH, HT, TH}. Both heads occurs in 1 of these 3 cases, so 1/3.

77. C
Explanation: The Newton-Raphson method, when approximating a simple root of a well-behaved function, exhibits a quadratic (order 2) rate of convergence.

78. B
Explanation: The local truncation error of the standard Trapezoidal rule is proportional to h^3, but the global accumulated error over the interval is of order h^2.

79. C
Explanation: The standard fourth-order Runge-Kutta method (RK4) evaluates the derivative function 4 times (k_1, k_2, k_3, k_4) in each step to achieve $O(h^4)$ accuracy.

80. B
Explanation: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. $0.7 = 0.4 + 0.5 - P(A \cap B)$, so $P(A \cap B) = 0.2$. Since $P(A) \times P(B) = 0.2$, the events are independent.

81. B
Explanation: The series adds successive odd numbers: $2(+3) = 5$, $5(+5) = 10$, $10(+7) = 17$, $17(+9) = 26$. The next is $26(+11) = 37$.

82. B
Explanation: Each block of letters increments by 6 positions in the alphabet: B→H→N→T, D→J→P→V, F→L→R→X. Thus, TVX.

83. A
Explanation: The word is written in reverse, and each letter is shifted by +1 in the alphabet. MEDICINE reversed is ENICIDEM, shifted +1 gives EOJDJEFM.

84. D
Explanation: The 'only son of my mother' is Suresh himself. Therefore, the boy in the photograph is the son of Suresh, making Suresh the boy's father.

85. A
Explanation: 10 km North, then 5 km East, then 10 km South. He ends up exactly 5 km to the East of his starting position.

86. C
Explanation: By syllogism: If all cats are dogs, and all dogs are birds, then all cats are birds (Conclusion I). It implies some birds are cats (Conclusion II).

87. C
Explanation: Drawing the circle: A is between B and C. B is to the right of E. D is between E and F. Ordering clockwise: E, B, A, C, F, D. To the left of C is F.

88. B
Explanation: At 3:15, the minute hand is at 90°. The hour hand moves $360°/12 = 30°$ per hour, so in 15 mins it moves $30° \times (15/60) = 7.5°$ past the 3. Angle $= 7.5°$.

89. B
Explanation: A non-leap year has 365 days, which is 52 weeks and 1 odd day. If the first day is a Monday, the last day (365th) will also be a Monday.

90. C
Explanation: Total studying $= 50 - 10 = 40$. $P(\text{Physics} \cup \text{Chem}) = P + C - \text{Both} \implies 40 = 30 + 25 - \text{Both}$. Thus, $\text{Both} = 55 - 40 = 15$.