Aptitude Test

Technical Assistant 'A' – Trade: Electronics

Total Pages-20

(To be filled by Candidate only)		*(For office purpose only)*
Name of the Candidate (in Capital Letters):		**Marks Obtained**
Application No. / Letter No.:		
Date of Examination:	(Signature of the Invigilator)	*(Signature of the Examiner)*

Time: 120 minutes **Full Marks: 100**

Instructions to the Candidate (परीक्षार्थी को निर्देश):

- Answer all the questions. **सभी प्रश्नों के उत्तर दें।**
- Put tick (√) mark for the correct answer of MCQ/Match Table and write in brief for descriptive type questions on the question paper itself. **MCQ/मैच टेबल के सही उत्तर के लिए सही (√) का निशान लगाएं और वर्णनात्मक प्रकार के प्रश्नों (यदि कोई हो) के लिए संक्षेप में लिखें।**
- Use Ball Point Pen only. **बॉल प्वाइंट पेन का ही इस्तेमाल करें।**
- All rough works to be done on blank spaces provided in this question paper. For any additional rough work purpose, use the separate sheet signed by the invigilator (May ask to the invigilator). **सभी रफ कार्य इस प्रश्न पत्र में उपलब्ध कराए गए रिक्त स्थानों पर किए जाने हैं। किसी भी अतिरिक्त रफ कार्य के उद्देश्य के लिए, निरीक्षक द्वारा हस्ताक्षरित अलग शीट का उपयोग करें (निरीक्षक से पूछ सकते हैं)।**
- No double markings on the answers of MCQ. **MCQ के उत्तरों पर कोई डबल मार्किंग नहीं किया जाना है।**
- Use of Calculators / Mobile Phones / Computing Device are <u>not allowed</u> in the examination hall. **परीक्षा हॉल में कैलकुलेटर/मोबाइल फोन/कंप्यूटिंग डिवाइस के उपयोग की अनुमति नहीं है।**
- If any clarification is required regarding the question, please ask to the invigilator. Don't discuss with any of the candidates during the examination hours. **यदि प्रश्न के संबंध में कोई स्पष्टीकरण आवश्यक है, तो कृपया निरीक्षक से पूछें। परीक्षा के समय के दौरान किसी भी परीक्षार्थी के साथ चर्चा न करें।**
- Submit this Question-cum-Answer sheet on time to the invigilator. **इस प्रश्न-सह-उत्तर पत्रक (शीट) को समय पर निरीक्षक के पास जमा करें।**

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(For Rough Work / Calculation)

PART-A: Technical Aptitude

A. Questions from No.1 to No.50 of Part A carry one mark each. (50X1) =50

1. A 10 μF capacitor is charged to 12 V and then connected to an identical uncharged 10 μF capacitor. The final voltage across each capacitor is:

   (A) 12 V (B) 6 V (C) 4 V (D) 3 V

2. Intrinsic carrier concentration in silicon is very small. If an n-type silicon has a large donor doping, the majority carrier concentration (electrons) is approximately equal to:

   (A) intrinsic concentration (B) donor concentration (C) half the donor concentration (D) zero

3. A silicon diode's forward current tends to increase with temperature. The short reason is:

   (A) bandgap decreases with temperature (B) mobility becomes infinite (C) supply voltage increases (D) diode area increases

4. In a BJT with Early voltage VA = 100 V, collector current IC = 1 mA. A small increase in VCE produces a small proportional increase in IC due to Early effect. This is best described as:

   (A) large change in IC (B) small change in IC (C) no change in IC (D) collector current becomes zero

5. A zener diode rated 5.6 V, 0.5 W is used on a 12 V supply. To keep the zener safe at maximum zener current, the series resistor should roughly be:

   (A) 13 kΩ (B) 12.8 kΩ (C) 11 kΩ (D) 1 kΩ
   (pick the closest reasonable value)

6. An op-amp with slew rate 1 V/μs is asked to reproduce a 1 V peak sine. The maximum practical frequency without slew-induced distortion is on the order of:

(A) 159 kHz (B) 159 Hz (C) 1590 Hz (D) 15.9 kHz

7. If a differential amplifier has differential gain Ad = 100 and CMRR = 60 dB, the common-mode gain Ac is roughly:

(A) 0.1 (B) 0.01 (C) 1 (D) 10

8. For a simple voltage-divider bias with R1 = 100 kΩ and R2 = 50 kΩ on 12 V supply (base divider only), the base voltage is about:

(A) 4 V (B) 6 V (C) 8 V (D) 2 V

9. Crossover distortion in a Class AB amplifier mainly results from:

(A) the base-emitter voltage drop region where transistors are off (B) power supply noise (C) transformer's leakage (D) output short circuit

10. RC low-pass filter with R = 1 kΩ and C = 0.01 μF has cutoff $f = 1/(2\pi RC) \approx$:

(A) 1.59 kHz (B) 15.9 kHz (C) 159 kHz (D) 159 Hz

11. A 4-bit ripple counter starting at 0000 will show what binary after 3 clock pulses?

(A) 0011 (B) 0010 (C) 0100 (D) 0001

12. A counter whose next state $Q_{n+1} = Q_n \oplus T$ (T is toggle input) is a:

(A) T-type counter (B) Johnson counter (C) up-counter only (D) shift register

13. Minimum number of NAND gates to create an XOR (2-input) is:

(A) 2 (B) 3 (C) 4 (D) 5

14. In a D flip-flop, if D = 1 and clock is pulsed many times, output Q will:

(A) remain 1 (B) toggle each pulse (C) remain 0 (D) be undefined

15. If propagation delay of a gate is 10 ns, a safe approximate maximum toggling frequency (single gate) is about:

(A) 50 MHz (B) 100 MHz (C) 25 MHz (D) 200 MHz

16. An 8-bit ADC with 5 V reference has LSB size ≈ 5 V / 256 =:

(A) 19.53 mV (B) 20 mV (C) 25 mV (D) 10 mV

17. 2's complement of 1101 (4-bit) is:

(A) 0010 (B) 0011 (C) 1110 (D) 0100

18. Logic expression Y = A'B + AB' is equivalent to:

(A) XOR (B) XNOR (C) NAND (D) NOR

19. In an R-2R DAC (4-bit), if only MSB = 1 and others = 0, the output is approximately:

(A) Vref/2 (B) Vref/4 (C) 3Vref/4 (D) Vref

20. A priority encoder with 8 inputs needs how many output lines to encode which input is active?

(A) 2 (B) 3 (C) 4 (D) 8

21. In FM, modulation index = frequency deviation / modulating frequency. If deviation = 15 kHz and modulating freq = 5 kHz, index =:

(A) 1 (B) 0.33 (C) 0.5 (D) 3

22. In AM, a carrier at 1 MHz modulated by 10 kHz has bandwidth:

(A) 30 kHz (B) 10 kHz (C) 20 kHz (D) 40 kHz

23. In PCM, increasing the number of bits n reduces quantization noise; noise power scales roughly as:

(A) $1/2^n$ (B) 2^n (C) n^2 (D) n

24. An antenna with gain 2 dB (≈ factor 1.58). If input power is 100 W, the radiated power (ignoring losses) is about:

(A) 158 W (B) 120 W (C) 100 W (D) 200 W

25. A phase-shift oscillator based on RC sections needs total phase shift of:

(A) 360° (B) 180° (C) 90° (D) 270°

26. For a simple clocked micro with clock 6 MHz, the period is:

(A) 1 µs (B) 0.1667 µs (C) 0.5 µs (D) 2 µs

27. An instruction that takes 4 T-states on a clock with period 0.5 μs needs total time:

(A) 4 μs (B) 1 μs (C) 2 μs (D) 0.5 μs

28. The 8051 microcontroller typical register bank allows up to how many general-purpose registers in one bank?

(A) 64 (B) 16 (C) 32 (D) 8

29. Resonant frequency of an LC circuit formula (angular/ordinary) commonly used as:

(A) $f = 1/(2\pi\sqrt{(LC)})$ (B) $f = 1/\sqrt{(LC)}$ (C) $f = \sqrt{(LC)}$ (D) $f = 2\pi\sqrt{(LC)}$

30. In a three-phase star connection, if line voltage = 400 V, phase (phase-to-neutral) voltage is:

(A) 230 V (B) 400 V (C) 690 V (D) 345 V

31. In C, the valid format specifier to print an integer is:

(A) %c (B) %d (C) %f (D) %s

32. In C, `int a = 5/2;` then value of a is:

(A) 2.5 (B) 3 (C) 2 (D) 5

33. In C, which operator has the **highest precedence**?

(A) * (multiplication) (B) + (addition) (C) () (parentheses) (D) = (assignment)

34. Which of the following is a valid C identifier?

(A) 2value (B) _temp (C) float (D) a-b

35. In C, which loop executes **at least once**?

(A) for loop (B) while loop (C) do-while loop (D) if-else

36. The keyword used to define a constant in C is:

(A) const (B) define (C) static (D) both A and B

37. In C, an array `int arr[5];` can store:

(A) 4 integers (B) 5 integers (C) unlimited integers (D) none

38. The base (radix) of hexadecimal number system is:

(A) 2 (B) 8 (C) 10 (D) 16

39. Binary number `1010` equals decimal:

(A) 5 (B) 10 (C) 12 (D) 15

40. Decimal 7 represented in 3-bit binary is:

(A) 011 (B) 111 (C) 101 (D) 110

41. A 3-input AND gate gives output 1 only when:

(A) All inputs are 0 (B) Any one input is 1 (C) All inputs are 1 (D) Two inputs are 1

42. A half adder has how many inputs and outputs?

(A) 2 inputs, 2 outputs (B) 2 inputs, 1 output (C) 1 input, 2 outputs (D) 3 inputs, 1 output

43. A full adder is made by combining:

(A) 2 half adders + 1 OR gate (B) 1 half adder + 1 OR gate (C) 2 XOR gates only (D) 2 NAND gates

44. In Boolean algebra, A + A = ?

(A) 0 (B) 1 (C) A (D) A'

45. The NOT gate is also called:

(A) Inverter (B) Buffer (C) Ex-OR (D) Flip-flop

46. In C, `char ch = 'A';` stores in memory:

(A) A (B) 65 (C) 97 (D) None

47. In C, the `break` statement is used to:

(A) Exit from a loop early (B) Skip to next iteration (C) Stop compilation (D) End program immediately

48. In C, `printf("%d", 2==3);` prints:

(A) 1 (B) 0 (C) 2 (D) 3

49. In digital logic, the flip-flop used to **store one bit** of data is:

(A) T flip-flop (B) SR flip-flop (C) D flip-flop (D) JK flip-flop

50. Which of these memories is volatile?

(A) ROM (B) RAM (C) Flash (D) Hard disk

B. Questions from No.51 to No.60 of Part A carry one mark each. (10X1) =10

Write the expanded name for the following

No.	Abbreviation	Full Form
51	MIMO	
52	Li-Fi	
53	PCIe	
54	SoC	
55	RISC	
56	CISC	
57	I^2C	
58	SPI	
59	SATA	
60	PoE	

C. Identify sensors (write specific name and model no,OEM or part no by which we can buy it from market) for each of the following detection: (1X10) =10

61. Which sensor would you use to measure the rotational speed of a rotating globe exhibit?

62. Which sensor can detect when a visitor's hand approaches an interactive touchscreen without touching it?

63. Which sensor is used to detect tilt or orientation of a robotic arm in a museum display?

64.Which sensor can detect the movement of a magnet attached to a small train model?

65.Which sensor is suitable for measuring the distance between a visitor and a display screen?

66.Which sensor can measure the precise angular position of a rotating model of the Earth?

67.Which sensor can detect if multiple visitors cross a restricted boundary in a museum display?

68.Which sensor can detect pitch, roll, and yaw in a handheld interactive device?

69.Which sensor can detect linear movement or speed of a magnetic slider in a physics demonstration?

70.Which sensor is suitable for non-contact measurement of visitor height for personalized interactive displays?

Part-B: Analytical Scenario Questions (2 questions)

(2X5) =10

71. An interactive VR exhibit showing the Mars mission is malfunctioning intermittently. Visitors report that the display freezes or resets randomly.

- What steps would you take to diagnose the problem?
- If the issue is traced to network latency, propose two solutions to ensure smooth visitor experience.
- How would you document this incident for future preventive maintenance?

72. The museum wants to reduce crowding in the popular "Space Exploration" zone. The current sensors count visitors but do not provide real-time alerts.

- How would you redesign the monitoring system to manage visitor density efficiently?
- Suggest one hardware and one software solution to guide visitors in real time.
- How would you evaluate the effectiveness of the new system?

PART-C: Technical System Design Ability (2 questions)

Sectional Marks total: (2X5) =20

- *Block diagram clarity: 3 marks*
- *Identification of components: 3 marks*
- *Description of part-wise actions: 4 marks*

Scenario: **10**

73. A museum exhibit consists of a tabletop surface mounted on a universal ball joint, allowing it to tilt freely in all directions. Visitors should be able to control the tilt of the table using a joystick or touch panel. The table should also automatically return to a horizontal position when not in use.

Task:

1. Design a system to control the tabletop tilt in both X and Y directions(x and y is placed in horizontal plane).

2. Draw a block diagram / data flow diagram of the system.

3. Describe the function of each part of the system and how it interacts to achieve the desired tilt control.Explain how sensors, actuators, and controllers work together in your system.

Scenario: 10

74. A science museum exhibit features a treadmill where visitors can walk at their own pace. As the visitor walks, a front display screen shows a virtual path, and the speed of the animation on the screen should match the visitor's walking speed.

Task:

- Propose a system to measure the visitor's walking speed and control the animation speed on the screen.
- Draw a block diagram / data flow diagram showing the system components.
- Describe the function of each part of the system and how the data flows to achieve synchronization between the treadmill and the display.
- Include sensor selection, signal processing, and control logic in your description.

Space for rough Work

**********END of Question and Answer Paper**********