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ESE 2024 : Prelims Exam
CLASSROOM TEST SERIES

E & T ENGINEERING

Test 16

Section A : Advanced Electronics + Materials Science

Section B : Electromagnetics + Computer Organization and Architecture

Section C : Advanced Comm.-2 + Electronic Measurements & Instrumentation-2

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2.	(d)	17.	(d)	32.	(c)	47.	(c)	62.	(b)
3.	(d)	18.	(c)	33.	(b)	48.	(c)	63.	(c)
4.	(b)	19.	(c)	34.	(b)	49.	(d)	64.	(c)
5.	(c)	20.	(b)	35.	(d)	50.	(d)	65.	(b)
6.	(a)	21.	(c)	36.	(c)	51.	(d)	66.	(d)
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13.	(d)	28.	(d)	43.	(b)	58.	(a)	73.	(b)
14.	(b)	29.	(a)	44.	(b)	59.	(c)	74.	(b)
15.	(c)	30.	(b)	45.	(c)	60.	(a)	75.	(c)

Detailed Explanation
Section A : Advanced Electronics + Materials Science

1. **(b)**

The total number of phosphorus atoms per unit area of Si surface is given by

$$S = 2N_s\sqrt{\frac{Dt}{\pi}}$$

where,

$$D = 10^{-14}\ \text{cm}^2/\text{sec}$$
$$t = 1\ \text{hr} = 3600\ \text{sec}$$
$$N_s = 10^{22}/\text{cm}^3$$
$$S = 2\times10^{22}\sqrt{\frac{10^{-14}\times3600}{3.14}}$$
$$S = 6.77\times10^{16}/\text{cm}^2$$

2. **(d)**

Dry oxidation has a slower growth rate, but it gives more controlled, more dense, and superior quality oxide than wet oxidation.

3. **(d)**

Implanted dose is given by

$$Q = \frac{Jt}{q}$$
$$Q = \frac{2\times10^{-6}\times3600}{1.6\times10^{-19}}$$
$$Q = 4.5\times10^{16}\ \text{atoms/cm}^2$$

4. **(b)**

Ion implantation is a low-temperature process by which ions of one element are accelerated into a solid target. The doping impurity is first ionized in high vacuum and then accelerated by high electric field before reaching the semiconductor substrate. The depth of dopants can be easily controlled and very shallow penetration is possible. It is a non-equilibrium technique which can introduce dopants into semiconductors beyond the solid solubility limit. Here, heavy doping is not limited by solid solubility limit because we can use high energy ion implantation for longer duration.

5. **(c)**

Epitaxial growth is best suited for the growth of a single crystalline layer in the same crystallographic orientation as the underlying substrate.

6. **(a)**

VLSI design is a sequential process with feedback loops. It involves stages like specification, logic design, and fabrication. The feedback loops allow for iterative refinement based on testing and simulation results.

7. **(a)**

The yield, or the percentage of working chips on a wafer, is a crucial factor affecting the IC cost. The higher the yield, the lower the cost per chip.

8. **(a)**

In standard SOP form, the Boolean expression is expressed as sum of product terms (minterms) wherein every variable appears in each product term, either in its true or complemented form. PROM consists of a fixed OR array followed by a programmable AND array. The OR array generates all the possible min-terms which are then fed to AND array resulting in an standard SOP form.

9. **(c)**

In DRAM, one transistor and a capacitor are required per bit, compared to six transistors in SRAM. Hence, DRAM has high density and low power dissipation compared to SRAM.

10. **(c)**

Using Deal Grove model, $t_{ox}^2 + At_{ox} = B(t + \tau)$

given, initial oxide thickness, $t_i = 0$

$\Rightarrow \quad \tau = 0$

$$t_{ox}^2 + 0.5t_{ox} = 0.6(1)$$

$$t_{ox}^2 + 0.5t_{ox} - 0.6 = 0$$

$$t_{ox} = 0.563\ \mu\text{m}$$

11. **(b)**

$$\text{Etch rate uniformity} = \frac{(\text{maximum etch rate}) - (\text{minimum etch rate})}{(\text{maximum etch rate}) + (\text{minimum etch rate})}$$

$$= \frac{950 - 700}{950 + 700} = 0.151 \times 100\%$$

$$= 15.1\%$$

12. **(c)**

Time required to remove 1 μm of oxide $= \dfrac{1\ \mu\text{m}}{r}$

Time required to remove 0.01 μm of stop layer

$$= \frac{0.01\ \mu\text{m}}{0.1r}$$

Given that, $$\frac{1\ \mu\text{m}}{r} + \frac{0.01\ \mu\text{m}}{0.1r} = 5.5 \text{ minutes}$$

$$\frac{1.1}{r} = 5.5 \text{ minutes}$$

$$\frac{1.1}{5.5} = r$$

$$r = \frac{11}{55} = \frac{1}{5} = 0.20\ \mu\text{m/minute}$$

13. (d)

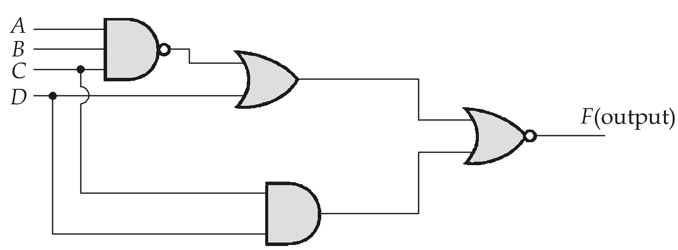
- In top down technique, generally a bulk material is taken and machined.
- Ball-milling is an important top-down approach, where macrocrytalline structure are broken down to nanocrystalline structures.
- Bottom up technique is used to build something from basic materials e.g. assembling materials atom-by-atom and molecule-by-molecule.
- Self-assembly of nanostructures is a process where atoms, molecules or nanoscale building blocks spontaneously organize into ordered structures or patterns with nanometer features. Hence, it is an example of bottom up technique.

14. (b)

Step 1: Selection of starting material
Step 2: Formation of thick oxide
Step 3: n-well diffusion
Step 4: Defining active regions
Step 5: Formation of polysilicon gate
Step 6: Implant n-MOS and p-MOS source and drain regions.
Step 7: Opening of contact windows
Step 8: Metallization

15. (c)

Consider the given logic circuit as shown below:



The boolean expression for the output (F) of the circuit, under no fault condition, can be given as,

$$(F)_{NF} = \overline{\overline{ABC} + D + CD}$$

$$(F)_{NF} = \overline{\overline{ABC} + D} = ABC\bar{D} \quad \text{...(1)}$$

The boolean expression for the output (F) of the circuit, when the line "T" is connected to the ground, can be given as

$$(F)_F = \overline{\overline{ABC} + D + 0}$$

$$(F)_F = ABC\bar{D} \quad \text{...(2)}$$

∴ from the equation (1), (2), it is clear that the boolean expression for the output (F) is same for both the situations (with and without fault). So, no input combination can detect the fault occurred in the circuit, when the line "T" is connected to the ground.

16. (d)

$$\overline{F_4} = A\overline{C} + \overline{B}\,\overline{C}$$

$$F_4 = \overline{A\overline{C} + \overline{B}\,\overline{C}}$$

$$F_4 = \overline{A\overline{C}} \cdot \overline{\overline{B}\,\overline{C}}$$

$$F_4 = (\overline{A} + C) \cdot (B + C)$$

$$F_4 = \overline{A}B + \overline{A}C + BC + C$$

$$F_4 = \overline{A}B + \overline{A}C + C = \overline{A}B + C$$

A \ BC	$\overline{B}\,\overline{C}$	$\overline{B}C$	BC	$B\overline{C}$
$\overline{A}$	(0)	1 (1)	1 (3)	1 (2)
A	(4)	1 (5)	1 (7)	(6)

$$F_4 = \Sigma m(1, 2, 3, 5, 7)$$

17. (d)

Types of ROM:

1. Mask Programmable Read Only Memory: This type of memory is referred to as ROM only. It is permanently programmed during the manufacturing process.
2. Programmable Read Only Memory (PROM): This type of memory comes from the manufacturer without any data stored in it. It allows users to program the data into the memory after the manufacturing process. Once programmed, the data in PROM becomes fixed and cannot be changed.
3. Erasable Programmable ROM: In this type of memory, data can be written any number of times, they are reprogrammable. They have a transparent quartz window through which the memory cells can be exposed to ultraviolet light for erasure.
4. Electrically Erasable PROM: In this type of memory, data can be stored any number of times and erased using electric charge.

18. (c)

Yield can be calculated as:

$$Y = (1 + Ad/\alpha)^{-\alpha}$$

$$Y = \left(1 + \frac{0.64 \times 1.25}{0.5}\right)^{-0.5}$$

$$Y = 0.62$$

19. (c)

For BCC, crystal structure, $N = 2 \text{ and } r = \dfrac{a\sqrt{3}}{4}$

$$\text{APF} = \frac{N \times \text{Volume of each sphere}}{\text{Total volume of each cell}}$$

$$= \frac{2 \times \frac{4\pi}{3}\left(\frac{a\sqrt{3}}{4}\right)^3}{a^3} = \frac{2 \times 4\pi}{3} \times \frac{3\sqrt{3}}{16 \times 4} = \frac{\pi\sqrt{3}}{8} = 0.68$$

20. (b)

$$\text{Thermal conductivity } (k) = \frac{1}{3}\frac{n\pi^2K^2T\tau}{m}$$

$$\text{Electrical conductivity } (\sigma) = \frac{nq^2\tau}{m}$$

$$\frac{k}{\sigma T} = \frac{1}{3}\frac{\pi^2K^2}{q^2} = L = 2.45 \times 10^{-8} W\Omega K^{-2} \quad \text{...(1)}$$

[K = Boltzmann's constant; L = Lorentz's number]

Equation (1) is called Weidemann Franz law of conductors.

21. (c)

Magnitization, $M = \chi H$
$= -8 \times 10^{-5} \times 2 \times 10^5$ A/m
$= -16$ A/m

Magnetic flux density,

$B = \mu_0(H + M)$
$= 4\pi \times 10^{-7}(2 \times 10^5 - 16) = 12.57 \times 2 \times 10^{-2}$
$= 25.14 \times 10^{-2} = 0.2514$ Wb/m^2

22. (c)

The addition of silicon to iron increases the electrical resistivity i.e. reduces the conductivity and thus, reduces the eddy currents and narrows the hysteresis loop.

Further, as Si content increases, magnetic permeability increases, due to low magneto-crystalline anisotropy and low magnetostrictive coefficients. Si also improves strength, thereby increasing the life of materials.

23. (a)

The susceptibility of the paramagnetic material is given by

$$\chi = \frac{N\mu_0\mu_B^2}{3KT}$$

$N = 10^{28}$ atoms/m^3
$\mu_B = 1.6 \times 10^{-23}$ A-m^2
$K = 1.38 \times 10^{-23}$ J/K
$T = 300$ K

$$\chi = \frac{10^{28} \times 4\pi \times 10^{-7} \times (1.6 \times 10^{-23})^2}{3 \times 1.38 \times 10^{-23} \times 300} = \frac{4\pi \times 10^{-2} \times 2.56}{3 \times 300 \times 1.38}$$

$$= \frac{12.57 \times 2.56 \times 10^{-2}}{9 \times 138} = 0.259 \times 10^{-3} \cong 2.6 \times 10^{-4}$$

24. (d)

A.B.S (Acrylonitrile, butadiene and styrene) is a common thermoplastic polymer and used as insulators in housings.

25. (d)

- Type-II super conductors are more useful than Type-I in practical applications by virtue of their higher critical temperature and critical magnetic fields.
- Superconducting state is an ordered state. There is a decrease in free energy of the system when there is a transition from the normal to the super conducting state, thus the entropy in the superconducting state is lower than the entropy in the normal state.

26. (b)

$$\text{Dielectric loss} = \frac{E^2 f \in_r \tan\delta}{1.8\times 10^{12}} \text{W/cm}^3$$

$$= \frac{40\times 40\times 10^6 \times 60\times 5.6\times 0.005}{1.8\times 10^{12}}$$

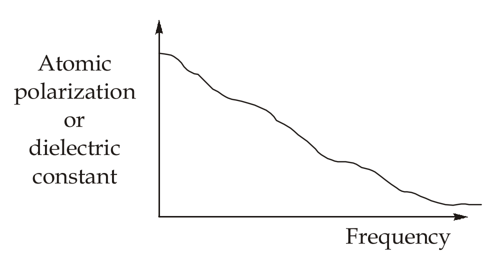
$$= \frac{16\times 6\times 56\times 5\times 10^{-6}}{18}$$

$$= \frac{4480}{3}\times 10^{-6} = 1493.33\times 10^{-6}$$

$$= 1.49 \text{ mW/cm}^3$$

27. (c)

At higher frequencies, charge carriers are unable to follow the rapid changes in the applied electric field. Hence, in an insulating material connected to an a.c. signal, the dielectric constant and atomic polarization decreases with frequency.



28. (d)

For Monoclinic crystal structure,

$$a \neq b \neq c$$

$$\alpha = \gamma = 90° \neq \beta$$

The Monoclinic bravais lattices can be:

- Simple (points at the eight corners of the unit cell).
- End centered (points at the eight corner and at two face centres opposite to each other).

29. (a)

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} = \frac{N \times \dfrac{\text{Atomic weight}}{\text{Avagadro's Number}}}{a^3}$$

$$6250 \times 10^3 = \frac{N \times 60.023}{(4 \times 10^{-10})^3 \times 6.023 \times 10^{23}}$$

$$N = \frac{6250 \times 10^3 \times (4 \times 10^{-10})^3 \times 6.023 \times 10^{23}}{60.023}$$

$$N = 4$$

Thus, the number of atoms per unit cube is equal to 4. Hence, the structure is FCC structure.

$$|b| = 2r = 2 \times \frac{\sqrt{2}}{4} \times a$$

$$= \frac{\sqrt{2}}{2} \times 4 \times 10^{-10} = 2\sqrt{2}\,\text{Å} = 2.828\,\text{Å}$$

Thus, magnitude of Burger vector = 2.828 Å.

30. (b)

Left handed material ($\mu < 0; \in_r < 0$) are also called meta materials (or) stealth materials.

Missiles are made up of meta material so that they are invisible to incoming electromagnetic (EM) wave, because EM waves are not reflected by the meta material objects. The objects becoming invisible to EM waves is called cloaking.

31. (c)

- CNT has low thermal expansion coefficient.
- Carbon nanotubes (CNTs) possess remarkable electrical conductivity properties. CNT's have the capacity to carry electric current 1000 times more than copper wires.
- Pressing (or) stretching nanotubes can change their electrical properties by changing the quantum states of the electrons in the carbon bonds.

32. (c)

Organic polymers are very good insulators. Example: PVC, PTFE, Polyethylene, Nylon, Synthetic rubber etc.

33. (b)

The conductivity associated with the insulating materials is due to the motion of ions and is, therefore called ionic conductivity. Usually, ionic conductivity only introduces losses into a material.

34. (b)

35. (d)

Barium Titanate has highest spontantaneous polarizability because of two reasons:

(i) Titanium ion has +4 unit charge.

(ii) It can be displaced over large distance.

36. (c)

- Most of the ceramic materials are dielectric and hence, they have good dielectric properties.
- Electrical resistance of ceramics materials is very high and it is used in electrical industry as electrical insulator.
- Ceramic materials exhibit excellent resistance to corrosion and are much better suited to withstand all environments. Since, ceramics are poor conductor of heat and electricity, therefore, are not susceptible to electrochemical corrosion as found in metals. Corrosion of ceramic materials generally involves chemical dissolution. Hence, Ceramic materials are frequently used.

37. (a)

DFT is a technique, which facilitates a design to become testable after production. It's the extra logic which we put in the normal design, during the design process, which helps its post-production testing.

38. (b)

The deviation from the perfect periodicity of atomic arrays in crystals is known as crystal defects. The defects in crystals may be confined to a point, line, surface and volume.

Section B : Electromagnetics + Computer Organization and Architecture

39. (c)

The reflection coefficient at the load is

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{60-80}{60+80}$$

$$\Gamma_L = \frac{-20}{140} = -\frac{1}{7}$$

$$|\Gamma_L| = \frac{1}{7}$$

The maximum voltage on the line $|V_{max}|$ = 100 V. Hence, we can write

$$100 = |V^+|(1 + |\Gamma_L|)$$

$$|V^+| = \frac{100}{1+|\Gamma_L|} = \frac{100}{1+\frac{1}{7}} = \frac{700}{8} = 87.5 \text{ V}$$

$$|I_{max}| = \frac{|V_{max}|}{Z_0} = \frac{100}{80} = 1.25\text{A}$$

Minimum current $$|I_{min}| = \frac{|V^+|}{Z_0}(1-|\Gamma_L|)$$

$$= \frac{87.5}{80}\left(1-\frac{1}{7}\right) = 1.09 \times \frac{6}{7} = \frac{15}{16}\text{A}$$

$$= 0.9375 \text{ A}$$

$$|V_{min}| = |I_{min}|Z_0 = \frac{87.5}{80} \times \frac{6}{7} \times 80 = 75 \text{ V}$$

40. (b)

The array has largest HPBW when it is in the end fire direction. So we get,

$$20^\circ = \frac{20\times\pi}{180^\circ} = \frac{\pi}{9} = \sqrt{\frac{2\lambda}{(N-1)d}}$$

$$N >> 1$$

$$\sqrt{\frac{2\lambda}{Nd}} = \frac{\pi}{9}$$

$$\frac{2\lambda}{Nd} = \frac{\pi^2}{81}$$

$$Nd = \frac{2\times 81}{\pi^2}\times\lambda$$

For array spacing $d = \lambda/2$,

$$N = \frac{2\times 81}{\pi^2}\times\frac{\lambda\times 2}{\lambda} = \frac{4\times 81}{\pi^2} = 32$$

41. (d)

The wave is incident from air to the material. Hence, we have

$$\eta_1 = \eta_0$$

$$\eta_2 = \frac{\eta_0}{\sqrt{9}}$$

The transmission coefficient

$$\tau = \frac{2\eta_2}{\eta_2+\eta_1} = \frac{\frac{2}{\sqrt{9}}}{\frac{1}{\sqrt{9}}+1} = \frac{2}{1+\sqrt{9}}$$

$$= \frac{2}{1+3} = \frac{2}{4} = \frac{1}{2}$$

The electric field inside the slab $E_t = \tau E_i = \frac{1}{2}\times 25 = 12.5 \text{ V/m}$

The transmitted magnetic field,

$$H_t = \frac{E_t}{\eta_2}$$

$$= \frac{125\times 3}{120\pi\times 10} = \frac{5\times 7}{16\times 22} = \frac{35}{352}$$

The power transferred to the slab is

$$P = E_t H_t = \frac{25}{2}\times\frac{35}{352} \cong 1.243 \text{ W/m}^2$$

42. (d)

Practically due to non ideal conductors there is attenuation in the guide, in the form of conductor losses, penetration losses, and dielectric heating losses.

43. (b)

The volume charge density is

$$\rho = \nabla \cdot D = \frac{1}{r\sin\theta}\cdot\frac{\partial}{\partial\theta}(D_\theta \sin\theta)$$

$$= \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\left[\frac{120\cos 2\theta}{r}\sin\theta\right]$$

$$= \frac{1}{r\sin\theta}\cdot\frac{\partial}{\partial\theta}\left[\frac{120}{2r}(\sin 3\theta - \sin\theta)\right]$$

$$= \frac{120}{2r^2\sin\theta}[3\cos 3\theta - \cos\theta]$$

$$= \frac{60}{r^2\sin\theta}[3\cos 3\theta - \cos\theta]$$

The charge enclosed in the region is

$$Q = \int_{\phi=0}^{2\pi}\int_{\theta=0}^{\pi/2}\int_{r=1}^{2}\frac{60}{r^2\sin\theta}(3\cos 3\theta - \cos\theta)r^2\sin\theta dr\, d\theta d\phi$$

$$= 60(2-1)\times 2\pi\int_{\theta=0}^{\pi/2}(3\cos 3\theta - \cos\theta)d\theta$$

$$= 120\pi\left[3\frac{\sin 3\theta}{3} - \sin\theta\right]_0^{\pi/2} = 120\pi[-1 - 1] = -240\pi \text{ C}$$

44. (b)

It is not possible to have isolate a magnetic poles (or magnetic charges). Thus the total flux through a closed surface in a magnetic field must be zero, that is

$$\oint_s \vec{B}\cdot d\vec{s} = 0$$

45. (c)

Inconsistency of continuity equation was present in Ampere's law and was corrected by addition of $\frac{\partial \vec{D}}{\partial t}$ in the law.

46. (d)

Microstrip antennas consist of a metallic patch on a grounded substrate. The metallic patch can take many different configuration. The rectangular and circular patches are the most popular.

47. (c)

- Integers m and n represents the number of $\frac{1}{2}$ cycle variation of magnetic field in the x and y-direction respectively.
- For TEM modes, the only way for the transverse fields to be non-zero with $E_z = H_z = 0$ is for $K_c = 0$, which yields

$$\gamma_g = \gamma = j\beta = \alpha_g + j\beta_g \quad \Rightarrow \quad \beta_g = \beta$$

- If the operating frequency is below the cutoff frequency, the wave will be attenuated.
- TM_{11} is the lowest order mode of all TM_{mn} modes.

48. (c)

$$\text{Pipeline time} = \max[100, 120, 160, 180, 200] + \text{Buffer Delay}$$
$$\text{Pipeline time} = 200 + 5 = 205 \text{ nsec}$$
$$\text{Execution time} = [n + k - 1] \times \text{Pipeline time}$$
$$= [1000 + 5 - 1] \times 205$$
$$= [1004] \times 205$$
$$= 205.82\ \mu\text{sec}$$

49. (d)

- CISC architecture aims to reduce the number of instructions per program while increasing the number of cycles per instruction. Hence, programs in CISC architecture takes less space in memory.
- RISC is used in high-end applications like video processing, telecommunications, and image processing whereas CISC is used in low-end applications such as personal applications.
- CISC processor uses microprogrammed control unit as compared to hardwired control unit used in RISC.

50. (d)

The following is Gantt Chart of execution:

P_1	P_2	P_2	P_2	P_4	P_3	P_1
0–1	1–2	2–3	3–4	4–5	5–8	8–12

Turn around time = Completion time – Arrival time

Process	Completion time	Arrival time	TAT
P_1	12	0	12
P_2	4	1	3
P_3	8	2	6
P_4	5	4	1

$$\text{Average turn around time} = \frac{12+3+6+1}{4} = \frac{22}{4} = 5.50 \text{ msec}$$

51. (d)

52. (d)

251 opcodes $\Rightarrow$ $\lceil \log_2 251 \rceil = 8$ i.e. 8 bits required for opcode.

Number of bits needed to represent register = $\log_2 32$ = 5 bits

opcode	R_1, R_2, R_3, R_4

Number of bits needed for instruction = 8 bits + 5 × 4 = 8 + 20 = 28 bits

[$\because$ 4 bits for 4 registers i.e., R_1 R_2 R_3 R_4]

53. (d)

$$\text{CPI} = \frac{25 \times 2 + 50 \times 1 + 25 \times 100}{100}$$

$$\text{CPI} = \frac{50 + 50 + 2500}{100} = 26$$

54. (d)

Instruction : "Load 1500"

Direct addressing mode: Since the content of location '1500' is '1700'. Hence, 1700 will be loaded.

Indirect addressing mode: The content of location '1500' is '1700' which provide the operand's address. The content of memory location '1700' is 200. Hence, 200 is loaded.

Base (indexed) Addressing mode: The operand's address is provided by

[1500 + 300] $\Rightarrow$ [1800]. The content of memory location '1800' is 1600 which is loaded into the accumulator.

55. (d)

Let the increment of j is 2^0, 2^1, ...2^i. The while loop condition is true until

$$2^i \le n \text{ or } i \le \log_2 n \text{ i.e., } i \le \lceil \log_2 n \rceil; \text{ as } i \text{ is an integer}$$

One extra comparison is required for the termination of while loop. So, total number of comparisons $= i + 1 = \lceil \log_2 n \rceil + 1$.

56. (b)

In polling based I/O, the processor keeps polling till the device is ready. Then the processor has to take care of transfer. This is too much overhead for processor.

In interrupt driven I/O, the polling overhead is reduced but during transfer, the processor does not do any useful work.

During DMA transfer, DMA controller requests for the data bus lines from the microprocessor through the HOLD pin. If the microprocessor acknowledges through the HLDA pin, the DMA controller can transfer the bulk data to the memory through these buses without interrupt mechanism. Thus, DMA-based I/O transfer does not use the CPU to transmit data to the main memory, therefore it has the highest throughput for very large data transfer.

Section C : Advanced Comm.-2 + Electronic Measurements & Instrumentation-2

57. (b)

$$\phi = (5 - 1) \times (7 - 1) = 24$$

If private key = e; public key = p then, $(e \times p) \bmod \phi = 1$

Here, Public key, $p = 5$ then,

$$(e \times p) \bmod \phi = 1$$

$$(e \times 5) \bmod 24 = 1$$

By options, we get $e_{min} = 5$ but it is discarded as RSA is a Asymmetric type of algorithm.

Asymmetric algorithm means it works on two different keys i.e., public key and private key.

Hence, for $e = 29$, $(e \times 5) \bmod 24 = 1$ is also satisfied.

Hence, $e_{min} = 29$

58. (a)

- Symmetric encryption is a encryption technique where data is encrypted and decrypted using a single, secrete crytographic key.
  Eg:- • Data Encryption Standard (DES)
  • Triple Data Encryption Standard (Triple DES)
  • Advance Encryption Standard (AES), etc....
- Asymmetric encryption is a encryption technique where data is encrypted and decrypted using different keys.
  Eg:- • Rivest Shamir Adleman (RSA)
  • Elliptical curve cryptography (ECC)
  • The Diffie-Hellman key exchange method, etc.

Hence, option (a) is not asymmetric encryption technique.

59. (c)

We know that,

Cluster size $N = i^2 + j^2 + (i \times j)$; where $i, j = 0, 1, 2, 3$ .....

For $i, j = 0, 1, 2,$ ...., Possible values of $N = 1, 3, 4, 7, 9, 12, 13, 16, 19, 21,$ ....

Hence, for any combination of i and j, N will never be 18.

60. (a)

- Link Control Protocol (LCP) is a part of Point – to – Point Protocol (PPP) that operates in the data link layer. It is responsible for establishing, configuring, testing, maintaining and terminating links for transmission.
- Point-to-Point Protocol (PPP) is a data link layer protocol. Hence, statement (2) is incorrect.
- Password Authentication Protocol (PAP) uses a two-way handshake process where the client sends their credentials to the server, the server verifies them, and the user is authenticated.

61. (a)

Length of IP address is 4 bytes in IPv4 and 16 bytes (256 bits) in IPv6.

	Class A	Class B	Class C	Class D	Class E
1. Range of first order	0-127	128-191	192-223	224-239	240-255
2. First octet start with bit	0	10	110	1110	1111
3. Number of possible networks	2^7-2	2^{14}-2	2^{21}-2	–	–
4. Network of possible hosts per network	$2^{24} - 2$ = 16777214 hosts	$2^{16} - 2$ = 65534 hosts	$2^8 - 2$ = 254 hosts	–	–
5. Network mask	8 bits	16 bits	24 bits	–	–

- Class D addresses are multicast address.
- Class E address are reserved for experimental purposes.

∴ Statement 2 and 4 are incorrect. Hence, option (a) is correct.

62. (b)

We have, $i = 3, j = 2, D = 4$ km

We know that,

$$\text{cluster size, } N = i^2 + j^2 + ij$$
$$N = 3^2 + 2^2 + (2 \times 3)$$
$$N = 19$$

We have relation $\frac{D}{R} = \sqrt{3N}$ or $\frac{D}{d} = \sqrt{N}$

where, R = radius of cell

and d = Distance between centres of adjacent cells ($d = \sqrt{3}R$)

We can use any of the one relation,

We take

Method (I):
$$\frac{D}{d} = \sqrt{N}$$
$$\frac{4}{\sqrt{19}} = d$$
$$d = 0.92 \text{ km}$$

Method (II):
$$\frac{D}{R} = \sqrt{3N}$$
$$\frac{D}{\sqrt{57}} = \text{R}$$
$$R = 0.53 \text{ km}$$
$$d = \sqrt{3}R$$
$$d = 0.92 \text{ km}$$

Hence, option (b) is correct.

63. (c)

We have, $\text{uplink}\left(\frac{C}{N_0}\right) = 80 \text{ dB-Hz}, \left(\frac{C}{N_0}\right)_{\text{overall}} = 77 \text{ dB-Hz}$

$$10\log_{10}\left(\frac{C}{N_0}\right)_{\text{up}} = 80 \text{ dB-Hz}, \left(\frac{C}{N_0}\right)_{\text{overall}} = 10^{7.7}$$
$$\left(\frac{C}{N_0}\right)_{\text{up}} = 10^8$$

We know that,
$$\frac{1}{(CNR)_{\text{overall}}} = \frac{1}{(CNR)_{\text{up}}} + \frac{1}{(CNR)_{\text{down}}}$$
$$\frac{1}{(CNR)_{\text{down}}} = \frac{1}{(CNR)_{\text{overall}}} - \frac{1}{(CNR)_{\text{up}}}$$
$$\frac{1}{(CNR)_{\text{down}}} = \frac{1}{10^{7.7}} - \frac{1}{10^8}$$

$$(CNR)_{\text{down}} = \frac{10^{15.7}}{10^8 - 10^{7.7}}$$

$$(CNR)_{\text{down}} = \frac{10^{15.7}}{10^8 - 5 \times 10^7} = \frac{10^{8.7}}{5}$$

$$(CNR)_{\text{down}} = 2 \times 10^{7.7}$$

$$10 \log_{10}(CNR)_{\text{down}} = 10 \log_{10}2 + 10 \log_{10}10^{7.7}$$

$$(CNR)_{\text{down}} \approx 80 \text{ dB-Hz}$$

Hence, option (c) is correct.

64. (c)

We have, $d = 4.12\left[\sqrt{h_t} + \sqrt{h_r}\right]km$, where h_t and h_r are in meters.

$$70 = 4.12\left[\sqrt{h_t} + \sqrt{h_r}\right]km$$

$$\sqrt{h_t} + \sqrt{h_r} = 17 \quad \text{...(i)}$$

According to question, $h_t - h_r = 17$

$$h_t = 17 + h_r \quad \text{...(ii)}$$

$$\sqrt{17 + h_r} + \sqrt{h_r} = 17$$

Now from options, h_r = 64 m. Hence, option (c) is correct.

65. (b)

We know that,

$$\text{Time period of satellite, } T = \frac{2\pi r}{V} = \frac{2\pi r^{3/2}}{\sqrt{GM}} \text{seconds}$$

Substituting, $G = 6.67 \times 10^{-11}$ Nm²/kg² → $G = 6.67 \times 10^{-11}\ \text{Nm}^2/\text{kg}^2$

M = Mass of earth = 5.98×10^{24} kg

We get, $T = (0.314 \times r^{3/2})$ μsec

66. (d)

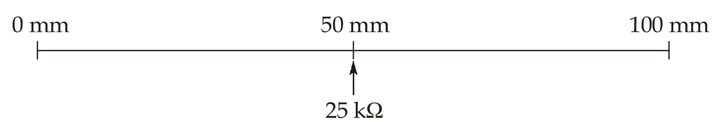
- Primary transducers are those device which actually sense the parameter under measurement.
  Eg.: • Bourdon tube
  • Bellows
  • Diaphragm
  Hence, statement 1 is correct.
- Secondary transducer are those device which take the output of primary transducer and convert it into an analogous electrical form.
  Eg.: Linear variable differential transformer (L.V.D.T)
- Active transducers are those devices whose output is in the form of electrical signal like charge, current or a voltage without any external source.
  For Eg.: • Thermocouples
  • Piezoelectric crystals
  • Photovoltaic cells
  Hence, statement 2 is correct.

- Passive transducers are those devices whose output is in the form of change in their electrical characteristics like the resistance, capacitance or inductance and hence, will require an external source of electrical stimulus for their operation.
  For Eg.: • Thermistors
  • RTD
  • Strain gauges
- Potentiometers are zero-order displacement transducers. They convert mechanical displacement into a proportional change in electrical resistance, providing an output voltage that varies with the physical position of the wiper contact. Hence, statement 3 is also correct. Hence, (d) is correct option.

67. (b)

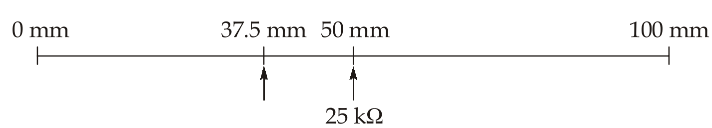
We have,

- 100 mm long potentiometer, Total resistance R_t = 50 kΩ
- Resistance of potentiometer per unit length = $\dfrac{50 \times 1000}{100} = 500\ \Omega/\text{mm}$
- Initially slider is at center as shown below i.e., $\dfrac{50\text{K}}{2} = 25\ \text{k}\Omega$



Case-I: For resistance A

- Slider moves 12.5 mm to the left.
- Resistance per unit length = 500 Ω/mm
  Change in resistance due to movement of slider by 12.5 mm = 500 × 12.5
  = 6.250 kΩ

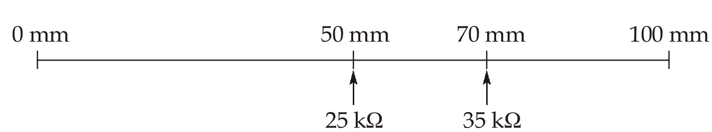


Resistance at 37.5 mm = 25 kΩ – 6.250 kΩ = 18.75 kΩ

Hence, value of resistance A = 18.75 kΩ

Case-II: For resistance B

Slider moves 20 mm to the right, it implies resistance at 70 mm
= 25 kΩ + (500 × 20)
= 25 kΩ + 10 kΩ
= 35 kΩ



Hence, value of resistance B = 35 kΩ

68. (c)

We have, $C_1 = \frac{\in A}{d_1}$ and $C_2 = \frac{\in A}{d_2}$

$$\frac{C_1}{C_2} = \frac{d_2}{d_1}$$

$$C_1 d_1 = C_2 d_2 \quad \text{...(i)}$$

According to given question,

$$C_1 = 150 \text{ pF}$$
$$C_2 = C_1 + 100\text{pF} = (150 + 100)\text{pF}$$
$$C_2 = 250 \text{ pF}$$
$$d_1 = 2 \text{ mm}$$

Now, put C_1, C_2 and d_1 in (i), we get,

$$150 \times 10^{-12} \times 2 \times 10^{-3} = 250 \times 10^{-12} \times d_2$$

$$d_2 = \frac{150 \times 2 \times 10^{-15}}{250 \times 10^{-12}}$$

$$d_2 = 1.2 \times 10^{-3}$$
$$d_2 = 1.2 \text{ mm}$$

Deflection produced by diaphragms $= d_1 - d_2$
$= 2 - 1.2$
$= 0.8$ mm

Hence, option (c) is correct.

69. (d)

The capsule is suitable for the measurement of dynamic pressure where as the remaining devices are suitable for static pressure measurement only.

Hence, option (d) is correct.

70. (a)

We have, charge sensitivity, $d = 2$ pC/N

force, $F = 7.5$ N

Voltage developed, $V_0 = gpt \quad$ ...(i)

where, g = voltage sensitivity

p = applied pressure

t = thickness of crystal

We know that, $$g = \frac{d}{\in} = \frac{2 \times 10^{-12}}{40.6 \times 10^{-12}}$$

$$g = \frac{2}{40.6} \text{V-m/N}$$

$$P = \frac{F}{A} \quad \text{and} \quad t = 2 \times 10^{-3} \text{ m}$$

$$P = \frac{7.5}{10 \times 5 \times 10^{-6}} = \frac{3}{20} \times 10^6 \text{ N/m}^2$$

Now, put g, p and t in (i) we get,

$$V_0 = \frac{2}{40.6} \times \frac{3}{20} \times 10^6 \times 2 \times 10^{-3}$$
$$V_0 = 14.78 \text{ V}$$
$$V_0 \approx 15 \text{ volt}$$

Hence, option (a) is correct.

71. (b)

Resistance wire strain gauges should have the following characteristics:

- The strain gauge should have a high value of gauge factor G_f. A high value of gauge factor result in high sensitivity.
  Hence, statement 1 is correct.
- The resistance of the strain gauge should be as high as possible since this minimizes the effects of undesirable variations of resistance in the measurement circuit.
  Hence, statement 2 is wrong.
- The strain gauge should not have any hysteresis effects in its response.
- The strain gauges should have a low resistance temperature coefficient. This is essential to minimise errors on account of temperature variations which affect the accuracy of measurement.
  Hence, statement 3 is correct.
  Statement 1 and 3 are correct. Hence, option (b) is correct.

72. (b)

$\frac{1}{T} = A + B \log_e R + C(\log_e R)^3$ is called as "Steinhart-Hart equation".

73. (b)

$$\text{Voltage signal, } V = 5 \sin(314t + 45°)$$
$$\text{Time period, } T = \frac{2\pi}{\omega} = \frac{2\pi}{314}$$
$$T = 20 \text{ ms}$$

$\because$ CRO horizontal scale has 20 divisions with base setting of 4 ms/div.

$\therefore$ Total time of horizontal scale = 20 divisions × 4 ms/div
= 80 ms

$\therefore$ Number of cycles displayed $= \frac{80 \text{ ms}}{20 \text{ ms}} = 4$

Hence, option (b) is correct.

74. (b)

Both the statements are correct and are independent to each other.
Hence, option (b) is correct.

75. (c)

The stop and wait ARQ protocol sends a data frame and then waits for an acknowledgment or ACK from the receiver. It is used for both error and flow control. Go-Back-N protocol is more efficient version of stop-and-wait protocol where it allows the sender to transmit multiple packets specified by window size (N) without waiting for an acknowledgment for each packet.

Hence, statement (II) is wrong.

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