



# POSTAL BOOK PACKAGE 2027

## ELECTRICAL ENGINEERING

### OBJECTIVE PRACTICE SETS VOLUME - IV

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# **ELECTRICAL MATERIALS**

**OBJECTIVE PRACTICE SETS**

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# Introduction to Engineering Materials

- Q.1** A unit cell is
- an agglomerated structure.
  - the basic building block of crystal.
  - the smallest group of atoms which when regularly repeated forms the crystal.
  - a cube containing the largest number of atoms.
- Q.2** **Assertion (A)** : A unit cell is analogous to a brick used in the building construction.  
**Reason (R)** : A unit cell is defined as the basic structural part in the composition of materials.
- Both A and R are true and R is the correct explanation of A.
  - Both A and R are true but R is not the correct explanation of A.
  - A is true but R is false.
  - A is false but R is true.
- Q.3** Consider the following statements:
- The crystal directions of a family must be parallel to one another.
  - Crystal directions and crystal plane are denoted by the Miller indices.
  - In cubic crystals, a crystal plane and a crystal direction normal to it have different indices.
  - The effective number of lattice points in unit cell is highest in case of face centered cubic space lattice.
- Which of the statements given above is/are correct?
- 2, 3 and 4
  - 2 and 4
  - 1, 2 and 3
  - 4 only
- Q.4** Consider the following statements associated with the atomic structure and chemical bonding:
- Covalent bond is non-directional.
  - The metallic bond is directional and generally weaker than ionic and covalent bonds.
  - Free electrons are responsible for the high thermal and electrical conductivities of metals.
  - The order of occupation of quantum states by electrons is determined by the Pauli exclusion principle, the Hund's rule, and the minimum energy criterion.
5. The bond energy is related to the enthalpy of atomization of the solid.
- Which of the statements given above are correct?
- 2, 3 and 5
  - 1, 2 and 4
  - 3, 4 and 5
  - 1, 3 and 5
- Q.5** The Miller indices of a plane are proportional to
- the reciprocal of numerical parameters of the intercepts
  - the square of unit cell dimensions
  - the intercepts of the planes on the coordinate axes
  - interplaner spacing
- Q.6** What is the Miller indices ( $h, k, l$ ) of a plane whose intercepts are  $a, b/2$  and  $3c$  on  $x, y$  and  $z$  axes respectively in a simple cubic unit cell?
- (3, 1, 6)
  - (6, 3, 1)
  - (1, 3, 6)
  - (3, 6, 1)
- Q.7** The atomic diameter of an FCC crystal (lattice parameter is  $a$ ) is
- $\frac{a\sqrt{2}}{2}$
  - $\frac{a\sqrt{2}}{4}$
  - $\frac{a\sqrt{3}}{4}$
  - $\frac{a}{2}$
- Q.8** A material is most stable when its potential energy is
- maximum
  - infinite
  - minimum
  - zero
- Q.9** Total number of electrons that can be accommodated in various electron states in a valence band of a given solid is equal to
- atomic number of the solid
  - half the number of atoms in the solid
  - the number of atoms in the solid
  - twice the number of atoms in the solid
- Q.10** Consider the following statements:  
 Secondary (or Molecular) bonds are
- The attraction forces exist between atoms or molecules.

2. Stronger than primary bonds.
3. Can be divided as electrostatic bonds.
4. Weaker than primary bonds.

Which of the above statements is /are correct?

- (a) 1 only                      (b) 2 and 3 only  
(c) 1 and 4 only              (d) 1, 2, 3 and 4

**Q.11** The geometrical configuration of one molecule of  $C_{60}$ -buckminsterfullerene contains

- (a) 12 hexagons and 20 pentagons of Carbon atoms.
- (b) 20 hexagons and 12 pentagons of Carbon atoms.
- (c) 20 hexagons and 20 pentagons of Carbon atoms.
- (d) 12 hexagons and 12 pentagons of Carbon atoms.

**Q.12** Assuming the Fermi level  $E_f$  to be independent of temperature,  $E_f$  may be defined as the level with an occupancy probability of

- (a) 0%                          (b) 50%  
(c) 75%                        (d) 100%

**Q.13** If ( $n$ ) is lattice points per unit cell of the cubic system, ( $N$ ) and ( $M$ ) are the Avogadro's number and atomic weight, respectively, and ( $\rho$ ) is the density of the element, then the lattice constant ( $a$ ) is

- (a)  $\left(\frac{M\rho}{nN}\right)^{1/3}$               (b)  $\left(\frac{NM}{n\rho}\right)^{1/3}$   
(c)  $\left(\frac{nM}{N\rho}\right)^{1/3}$               (d)  $\left(\frac{N\rho}{nM}\right)^{1/3}$

**Q.14** Consider the following statements in respect of energy bands in a solid.

1. Energy bands at high energy have more width than those bands at low energy.
2. Low energy bands correspond to valence electrons.
3. There are always some energy bands that are not filled.

Which of these statements is/are correct?

- (a) 1, 2 and 3                  (b) 1 and 2  
(c) only 2                        (d) 1 and 3

**Q.15** Lattice constants and angles of Triclinic crystal are:

- (a)  $a = b = c, \alpha = \beta = \gamma \neq 90^\circ$ .
- (b)  $a = b \neq c, \alpha = \beta = 90^\circ, \gamma = 120^\circ$ .
- (c)  $a \neq b \neq c, \alpha = \gamma = 90^\circ \neq \beta$ .
- (d)  $a \neq b \neq c, \alpha \neq \beta \neq \gamma \neq 90^\circ$ .

**Q.16** The crystal structure of an element is face centered cubic with cube side length 'a'. The atomic packing fraction and radius of atom in terms of cube side will be respectively.

- (a)  $\frac{\pi}{3\sqrt{3}}, \frac{a}{2\sqrt{2}}$               (b)  $\frac{\pi}{3\sqrt{2}}, \frac{a}{2\sqrt{3}}$   
(c)  $\frac{\pi}{3\sqrt{2}}, \frac{a}{2\sqrt{2}}$               (d)  $\frac{\pi}{3\sqrt{3}}, \frac{a}{2\sqrt{3}}$

**Q.17** Consider the following statements:

1. An increase in BCC iron volume is observed when heated due to change of BCC iron to FCC iron.
2. If the dislocation density in the crystal is high, it results in high mechanical strength of crystal.
3. Ionic crystals are hard and corrosive both in nature.

Which of the above given statements are correct?

- (a) 1 and 2 only              (b) 1 and 3 only  
(c) 2 and 3 only              (d) 1, 2 and 3

**Q.18** What type of defect causes F-centers in a crystal?

- (a) Stoichiometric defect
- (b) Metal excess defect due to anion vacancies
- (c) Metal excess defect due to extra cations
- (d) Frenkel defect

**Q.19** Point imperfections, during interaction with each other,

- (a) lower their total energy
- (b) are not affected at all
- (c) are thermodynamically stable
- (d) both (a) and (c)

**Q.20** If there are six electrons in the  $d$  orbital of a transition metal, the number of unpaired electrons are

- (a) 6                              (b) 5  
(c) 4                              (d) 0

**Q.21** A material has a face-centered cubic structure with an ionic radius of 1.06 Å. Calculate the inter planar separation for (110) planes.

- (a) 3.119 Å                      (b) 1.731 Å  
(c) 2.119 Å                      (d) 1.499 Å

**Q.22** What is the packing fraction of a BCC (body-centered cubic) unit cell?

- (a)  $\frac{\sqrt{3}\pi}{16}$                           (b)  $\frac{\sqrt{3}\pi}{8}$   
(c)  $\frac{\sqrt{3}\pi}{12}$                           (d)  $\frac{\sqrt{2}\pi}{8}$

**Answers Introduction to Engineering Materials**

1. (c)    2. (a)    3. (b)    4. (c)    5. (a)    6. (d)    7. (a)    8. (c)    9. (a)  
 10. (c)    11. (b)    12. (b)    13. (c)    14. (d)    15. (d)    16. (c)    17. (b)    18. (b)  
 19. (d)    20. (c)    21. (c)    22. (b)

**Explanations Introduction to Engineering Materials**

**1. (c)**

When many unit cells repeat in a three-dimensional space, a crystal is obtained. The structure of a crystal is same as that of a repeating unit cell.

**2. (a)**

A unit cell is defined as the basic structure part in the composition of materials. It is analogous to a brick used in the building construction. So, Assertion is correct and Reason is correct explanation of it.

**3. (b)**

- The crystal directions of a family are not necessarily parallel to one another. Hence, statement-1 is not correct.
- Statement-2 is correct.
- In cubic crystals, a crystal plane and a crystal direction normal to it have the same indices. Hence, statement-3 is not correct.
- The effective number of lattice points in unit cell is highest, i.e., 4 in case of face-centered cubic space lattice. In case of simple cubic it is 1 and in case of BCC it is 2. Hence, statement-4 is correct.

**4. (c)**

- The sharing of electrons between neighbouring atoms results in a covalent bond, which is directional. Hence, statement-1 is not correct.
- The metallic bond is non-directional and generally weaker than ionic and covalent bonds. Thus, statement-2 is not correct.
- Free electrons are responsible for the high thermal and electrical conductivities. Hence, statement-3 is correct.
- Statement-4 is correct.
- The magnitude of the energy released, when two atoms come together from a large distance of separation to the equilibrium distance, is

called the bond energy. It is related to the enthalpy of atomization of the solid. Hence, statement-5 is correct.

**5. (a)**

Miller indices are expressed as a reciprocal of intercepts made by the plane on the three rectangular  $x$ ,  $y$  and  $z$  respectively.

**6. (d)**

The intercepts  $C_1$  (along  $x$ -axis) =  $a$ ,  
 $C_2$  (along  $y$ -axis) =  $b/2$ ,  
 and  $C_3$  (along  $z$ -axis) =  $3c$

Therefore, 
$$p = \frac{C_1}{a} = \frac{a}{a} = 1$$

$$q = \frac{C_2}{b} = \frac{b/2}{b} = \frac{1}{2}$$

and 
$$r = \frac{C_3}{c} = \frac{3c}{c} = 3$$

$\therefore$  
$$h = \frac{1}{p} = \frac{1}{1} = 1$$

$$k = \frac{1}{q} = \frac{1}{1/2} = 2$$

and 
$$l = \frac{1}{r} = \frac{1}{3}$$

Hence,  $(h, k, l) = \left(1, 2, \frac{1}{3}\right) = \frac{1}{3}(3, 6, 1) = (3, 6, 1)$

(Since Miller indices is always an integer)

**7. (a)**

In FCC crystal, diagonal of each face

$$= 4r = \sqrt{2}a$$

(Where,  $r$  = radius of each atom)

The atomic diameter of an FCC crystal

$$= 2r = \frac{\sqrt{2}a}{2} = \frac{a}{\sqrt{2}}$$

**8. (c)**

A material is most stable when its potential energy is minimum.

9. (a)

Atomic number represents the total number of valence electrons present in various energy state in valence band.

10. (c)

Secondary or molecular bonds are either ion-dipole interaction, dipole-dipole interaction and Vander walls are weaker than primary bonds (ionic, covalent).

11. (b)

It contains 20-hexagons and 12-pentagons of carbon atoms.

12. (b)

Fermi-Dirac probability function  $F(E)$  is given by

$$F(E) = \frac{1}{1 + e^{(E-E_F)/kT}}$$

where,  $E_F$  = Fermi level

if  $E = E_F$  then  $F(E) = \frac{1}{2}$  for any value of temperature. Thus, the fermi level represents the energy state with 50% probability of being filled if no forbidden band exists.

13. (c)

$$\therefore \rho = \frac{nM}{Na^3} \Rightarrow a^3 = \frac{nM}{N\rho}$$

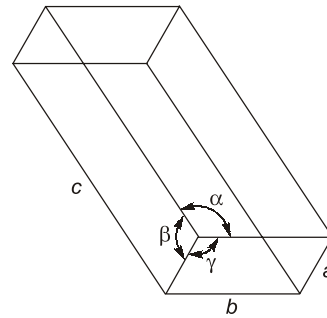
$$a = \left( \frac{nM}{N\rho} \right)^{1/3}$$

where,  $M$  = Atomic weight  
 $\rho$  = Density of element  
 $n$  = Lattice point per unit cell  
 $N$  = Avogadro's number  
 $a$  = Lattice constant

14. (d)

- Bands of higher energy are splitted into more bands as outermost level splits first and inner level splits after.
- Partially filled band refer to free or valence electrons possessing higher energy.
- Valence band is the highest range of electron energies in which electrons are normally present at zero temperature.
- Some energy bands like conduction band may be unfilled.

15. (d)



Triclinic  
 $a \neq b \neq c$   
 $\alpha \neq \beta \neq \gamma$

16. (c)

Atomic packing fraction for face centre cubic structure :  $\frac{4 \times \text{Volume of atom}}{\text{Volume of cube}}$

For face centered cube

No. of atoms per unit cell:

$$\frac{1}{8} \times 8 + 6 \times \frac{1}{2} = 4$$

For face centered cubic system,

$$4r = a\sqrt{2}$$

Where  $r$  is atomic radius and  $a$  is cube side length

$$r = \frac{a\sqrt{2}}{4} = \frac{a}{2\sqrt{2}}$$

$$\therefore \text{Atomic packing fraction} = \frac{4 \times \frac{4}{3} \pi \left( \frac{a}{2\sqrt{2}} \right)^3}{a^3}$$

$$= 4 \times \frac{4}{3} \pi \times \frac{a^3}{8 \times 2\sqrt{2} a^3} = \frac{\pi}{3\sqrt{2}}$$

17. (b)

If dislocation density is high, mechanical strength of material decreases.

18. (b)

F-centers are non-stoichiometric defect where electrons are trapped in anion vacancies and produced by the exposure of an alkali metal halide crystal to the alkali metal vapour.

19. (d)

Point imperfections are imperfect point-like regions in the crystal. These defects are of one or two atomic diameters only. Hence, these are called two-dimensional defects.

# **COMPUTER FUNDAMENTALS**

## **OBJECTIVE PRACTICE SETS**

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# Memory Organization and IO Organization

- Q.1** More than one word are put in one cache block to
- Exploit the temporal locality of reference in a program.
  - Exploit the spatial locality of reference in a program.
  - Reduce the miss penalty.
  - None of the above
- Q.2** The access time of a word in a 4 MB main memory is 100 ns. The access time of a word in a 32 kB data cache memory is 10 ns. The average data cache hit ratio is 0.95. The effective memory access time is
- 9.5 ns
  - 15 ns
  - 20 ns
  - 50 ns
- Q.3** A memory system of size 128 K bits is required to be designed using memory chips which have 12 address lines and 4 data lines each. The number of such chips required to design the memory system is
- 64
  - 4
  - 8
  - 16
- Q.4** The main memory of a computer has 2 cm blocks while the cache has 2 c blocks. If the cache uses the set associative mapping scheme with 2 blocks per set, then block k of the main memory maps to the set
- $(k \bmod m)$  of the cache
  - $(k \bmod c)$  of the cache
  - $(k \bmod 2c)$  of the cache
  - $(k \bmod 2cm)$  of the cache
- Q.5** When an interrupt occurs, an operating system
- ignores the interrupt
  - always changes state of interrupted process after processing the interrupt
  - always resumes execution of interrupted process after processing the interrupt
  - may change state of interrupted process to 'blocked' and schedule another process
- Q.6** A system uses FIFO policy for page replacement. It has 4 page frames with no pages loaded to begin with. The system first accesses 100 distinct pages in some order and then accesses the same 100 pages but now in the reverse order. How many page faults will occur?
- 196
  - 192
  - 197
  - 195
- Q.7** If the associativity of a processor cache is doubled while keeping the capacity and block size unchanged, which one of the following is guaranteed to be NOT affected?
- Width of tag comparator
  - Width of set index decoder
  - Width of way selection multiplexor
  - Width of processor to main memory data bus
- Q.8** According to temporal locality, processes are likely to reference pages that
- have been referenced recently.
  - are located at address near recently referenced pages in memory.
  - have been preloaded in memory.
  - None of these
- Q.9** The principle of locality justifies the use of
- Interrupts
  - Threads
  - DMA
  - Cache Memory
- Q.10** Consider a system with 2 level cache. Access times of level 1 cache, level 2 cache and main memory are 1 ns, 10 ns and 500 ns respectively. The hit rates of level 1 and level 2 caches are 0.8 and 0.9 respectively. What is the average access time of the system ignoring the search time within the cache?
- 13.0
  - 12.8
  - 12.6
  - 12.4
- Q.11** A disc drive has an average seek time of 10 ms, 32 sectors on each track and 512 bytes per sector. If the average time to read 8 kbytes of

continuously stored data is 20 ms, what is the rotational speed of the disc drive?

- (a) 3600 rpm                      (b) 6000 rpm  
(c) 3000 rpm                      (d) 2400 rpm

**Q.12** The access time of a cache memory is 100 ns and that of main memory is 1  $\mu$ s. 80% of the memory requests are for read and others are for write. Hit ratio for read only accesses is 0.9. A write through procedure is used. The average access time of the system for both read and write requests is

- (a) 200 ns                      (b) 360 ns  
(c) 720 ns                      (d) 1100 ns

**Q.13** A computer system has a 4 K word cache organized in block-set associative manner with 4 blocks per set, 64 words per block. The numbers of bits in the SET and WORD fields of the main memory address formula are respectively

- (a) 15 and 4                      (b) 6 and 4  
(c) 7 and 2                      (d) 4 and 6

**Q.14** Which of the following requires a device driver?

- (a) Register                      (b) Cache  
(c) Main memory                      (d) Disk

**Q.15** Which of the following semiconductor memory is used for cache memory?

- (a) SRAM                      (b) DRAM  
(c) ROM                      (d) PROM

**Q.16** In a cache with 64-byte cache lines, how many bits are used to determine which byte within a cache line an address points to?

- (a) 16                      (b) 8  
(c) 6                      (d) 3

**Q.17** Consider a system that uses interrupt driven I/O for a particular device which has an average data transfer rate of 8 kbps. The processing of the interrupt which includes the time to jump to ISR, its execution and returning to the main program is 100  $\mu$ s. What fraction of processor time consume by the device, if the device interrupts for every 1 byte (in %)?

- (a) 80                      (b) 40  
(c) 20                      (d) 100

**Q.18** The write through procedure is used

- (a) To write on the memory directly.  
(b) To write and read from memory simultaneously.  
(c) To write directly on the memory and cache whenever a hit occurs on a cache.  
(d) None of the above.

**Q.19** The fastest data access is provided using

- (a) Caches                      (b) DRAM's  
(c) SRAM's                      (d) Registers

**Q.20** The minimum time delay between the initiations of two independent memory operations is called

- (a) Access Time                      (b) Cycle Time  
(c) Transfer Time                      (d) Latency Time

**Q.21** A dynamic RAM has a memory cycle time of 64 nsec. It has to be refreshed 100 times per msec and each refresh takes 100 nsec. What percentage of the memory cycle time is used for refreshing?

- (a) 10                      (b) 6.4  
(c) 1                      (d) 0.64

**Q.22** A cache contains  $n$  blocks and main memory contains  $m$  blocks. If  $k$ -way set associative mapping is used then what will be number of TAG bits.

- (a)  $\log_2 \frac{mk}{n}$                       (b)  $\log_2 \frac{m}{n}$   
(c)  $\log_2 \frac{nk}{m}$                       (d)  $\log_2 \frac{mn}{k}$

**Q.23** Which of the following statements are true?

- Update bit is used in the write back cache to indicate the cache updation.
  - In hierarchical memory access organization CPU perform read and write operation on only level 1 memory.
  - In simultaneous memory access organization CPU perform read and write operation on any level of memory.
- (a) 1 and 2 only                      (b) 1 and 3 only  
(c) 2 and 3 only                      (d) 1, 2 and 3 only

**Q.24** Which of the following is true?

- (a) In write through protocol, cache location and main memory location are updated simultaneously.  
(b) In write back protocol, cache location and main memory location are updated simultaneously.  
(c) Modified or dirty bits are used by write through protocol.  
(d) None of these

**Q.25** In a vectored interrupt :

- (a) the interrupting device supplies the branch information to the processor through an interrupt vector.  
(b) the CPU does not know, which device cause the interrupt without polling each I/O interface.

**Answers Memory Organization and IO Organization**

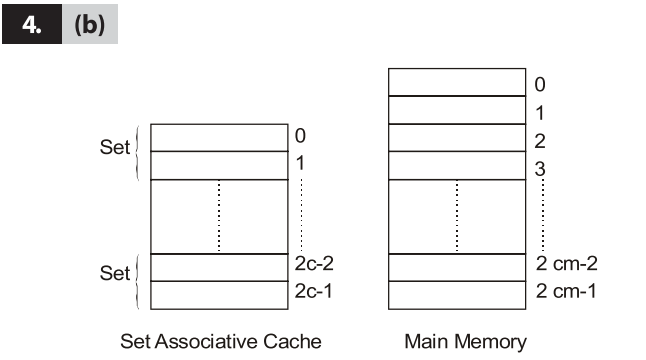
1. (b) 2. (b) 3. (c) 4. (b) 5. (d) 6. (a) 7. (d) 8. (a) 9. (d)  
 10. (a) 11. (b) 12. (b) 13. (d) 14. (d) 15. (a) 16. (c) 17. (a) 18. (c)  
 19. (d) 20. (b) 21. (c) 22. (a) 23. (d) 24. (a) 25. (a) 26. (b) 27. (d)  
 28. (b) 29. (b) 30. (d) 31. (a) 32. (a) 33. (d) 34. (d) 35. (a)

**Explanations Memory Organization and IO Organization**

**1. (b)**  
 Spatial Locality : If a particular storage location is referenced at a particular time, then it is likely that nearby memory locations will be referenced in the near future. Thus keeping more than one block helps in using spatial locality concept.

**2. (b)**  
 Hit ratio,  $H_c = 0.95$   
 Cache Memory Access Time  
 $T_c = 10 \text{ ns}$   
 Main Memory Access Time  
 $T_m = 100 \text{ ns}$   
 $EAT = H_c(T_c) + (1 - H_c)(T_c + T_m)$   
 $EAT = 0.95 \times 10 + 0.05 \times 110$   
 $EAT = 9.5 + 5.5$   
 $EAT = 15 \text{ ns}$

**3. (c)**  
 Size of chip =  $2^{12} \times 4 \text{ bits}$   
 Size of memory =  $128 \text{ k bits}$   
 Number of chips =  $\frac{2^7 \times 2^{10}}{2^{12} \times 2^2} = 8$



Number of set in set associative cache  
 $= \frac{\text{number of blocks in cache}}{\text{number of blocks in one set}} = \frac{2c}{2} = c$   
 Number of sets in cache =  $c$   
 Therefore, the block  $k$  of the main memory maps to the set  $(k \text{ mod } c)$  of the cache.

**5. (d)**  
 An interrupt is a signal from a device attached to a computer or from a program within the computer that causes the main program that operates the computer to stop and figure out what to do next. After the interrupt signal is sensed, it may change state of interrupted process to 'blocked' and schedule another process.

**6. (a)**  
 FIFO policy for page replacement used.  
 Access 100 distinct pages by taking some example: 2 3 4 5 6 7 8 9  
 So by loading it get

5
4
3
2

= 4 page fault ,

9
8
7
6

= 4 page fault

and now access these page in reverse so

9	8	7	6
---	---	---	---

So no page fault for these

5	4	3	2
---	---	---	---

page fault for these

9
8
7
6

5
4
3
2

4 page fault

So, total =  $4 + 4 + 4 = 12$  page fault  
 For 8 pages =  $2 \times 8 - 4 = 12$   
 So, for  $n$  pages =  $2n - 4$   
 So, for 100 pages =  $2 \times (100) - 4 = 196$

**7. (d)**  
 Assume,

Tag	Set	Word
12	8	4

Here  $k = 4$

⇓ when associativity doubled

Tag	Set	Word
13	7	4

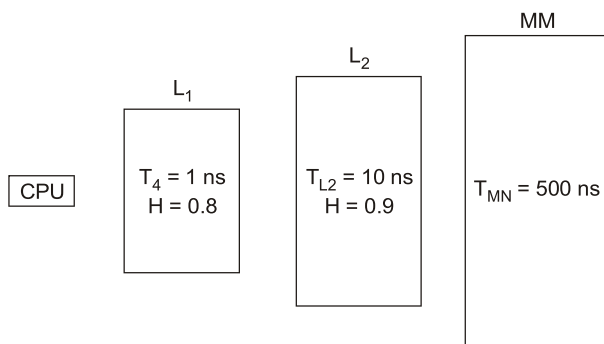
- Since, tag bits have been changed thus width of a Tag comparator changes.
- Since, width of set bits changed thus width of a set index decoder.
- Width of multiplexor change since k changes.

**8. (a)**

Temporal locality says that recently executed instruction is likely to be executed very soon.

**9. (d)**

Principle of locality states that many instruction in localized areas of the programs are executed repeatedly during short time period and the remainder of the program is accessed relatively less frequently. This is where use of cache comes into existence.

**10. (a)**

$$\begin{aligned} T_{\text{avg}} &= 0.8 \times 1 + 0.2 \times 0.9 \times (1 + 10) \\ &\quad + 0.2 \times 0.1 \times 511 \\ &= 0.8 + 1.98 + 10.22 \\ &= 13 \text{ ns} \end{aligned}$$

**11. (b)**

Average access time  
= avg. seek time + avg. rotational latency  
+ avg. transfer time

$$\text{Here, for 1 round} = \frac{60 \text{ sec}}{n} = \frac{60,000}{n} \text{ msec}$$

$$\therefore \text{Average rotational latency} = \frac{60,000}{2n}$$

$$\text{Also : } 32 \times 512 \text{ bytes} = 1 \text{ track} = \frac{60,000}{n} \text{ msec}$$

$$\begin{aligned} \therefore 8 \text{ k byte} &= \frac{60,000 \times 8 \times 2^{10}}{n \times 32 \times 512} \\ &= \frac{60,000}{2n} \text{ msec} \end{aligned}$$

$$\begin{aligned} \text{So, } \frac{60000}{2n} + \frac{60000}{2n} + 10 &= 20 \\ \therefore n &= 6000 \text{ rpm} \end{aligned}$$

**12. (b)**

$$\begin{aligned} \text{Read access time} &= HT_c + (1 - H)(T_c + T_m) \\ &= 0.9 \times 100 + 0.1 \times (100 + 1000) \text{ nsec} = 200 \text{ nsec.} \\ \text{Total access time} &= (0.8 \times 200 + 0.2 \times 1000) \text{ nsec} = 360 \text{ nsec.} \end{aligned}$$

**13. (d)**

$$\text{No. of blocks} = \frac{4K}{64} = 64$$

$$\text{No. of sets} = \frac{64}{4} = 16$$

$\Rightarrow$  4 bits for SET

Each block has 64 words

$\Rightarrow$  6-bits required for word.

Tag	Set	Word
	4 Bits	6 Bits

**14. (d)**

Disk is the IO device attached externally to the processor. Therefore, disk requires a device driver.

**15. (a)**

SRAM or Static Random Access memory is a type of semiconductor RAM that exhibits data remanence. While DRAM or Dynamic Random Access Memory must be periodically refreshed. SRAM is faster and more expensive than DRAM; it is typically used for CPU cache while DRAM is used for a computer's main memory.

**16. (c)**

$$\text{Word offset} = \log_2 64 = 6 \text{ bit}$$

**17. (a)**

An interrupt is generated when 1 byte is ready.

Time taken to ready 1 byte data is

$$1 \text{ byte} = \frac{1}{8K} \text{ sec, i.e., } 125 \mu\text{s.}$$

Thus, after every  $125 \mu\text{s}$ , 1 interrupt is generated. And for each interrupt processor does work which takes  $100 \mu\text{sec}$ .

Hence, fraction of processor time consumed

$$= \frac{100}{125} = 0.8 \text{ i.e., } 80\%.$$

# **COMMUNICATION SYSTEMS**

## **OBJECTIVE PRACTICE SETS**

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# Fourier Analysis of Signals, Energy and Power Signals

**Q.1** Let  $x(t)$  be a periodic signal with fundamental period  $T$  and Fourier series coefficient of  $\text{Re}\{x(t)\}$  (where  $\text{Re}$  denotes the real part of signal) is

- (a)  $\frac{a_k + a_k^*}{2}$       (b)  $\frac{a_k - a_k^*}{2}$   
 (c)  $\frac{a_k^* + a_{-k}}{2}$       (d)  $\frac{a_k^* - a_{-k}}{2}$

**Q.2** If  $G(f)$  represents the Fourier transform of a signal  $g(t)$  which is real and odd symmetric in time then

- (a)  $G(f)$  is complex  
 (b)  $G(f)$  is imaginary  
 (c)  $G(f)$  is real  
 (d)  $G(f)$  is real and non-negative

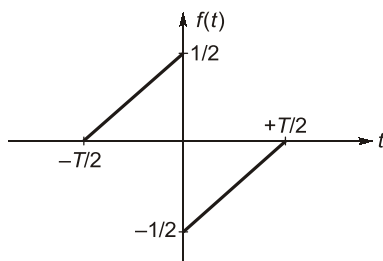
**Q.3** The amplitude spectrum of Gaussian pulse is

- (a) uniform      (b) a sine function  
 (c) Gaussian      (d) an impulse function

**Q.4** A signum function is

- (a) zero for  $t$  greater than zero  
 (b) zero for  $t$  less than zero  
 (c) unity for  $t$  greater than zero  
 (d)  $2u(t) - 1$

**Q.5** A function  $f(t)$  is shown in figure.



The Fourier transform  $F(\omega)$  of  $f(t)$  is

- (a) real and even function of  $\omega$   
 (b) real and odd function of  $\omega$   
 (c) imaginary and odd function of  $\omega$   
 (d) imaginary and even function of  $\omega$

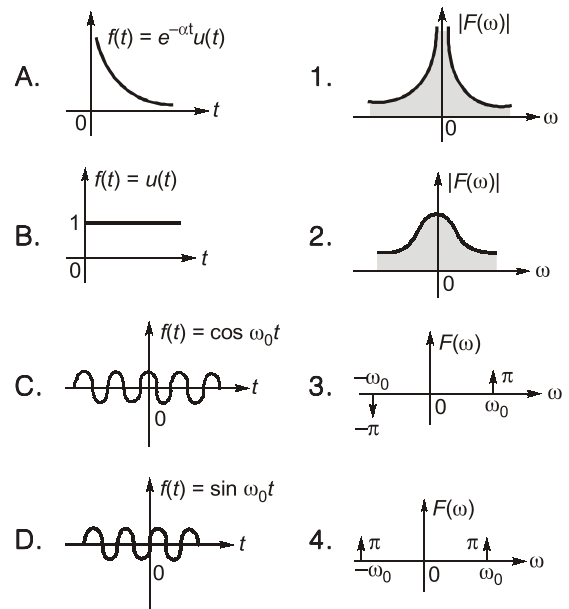
**Q.6** What is the autocorrelation function of a rectangular pulse of duration  $T$ ?

- (a) A rectangular pulse of duration  $2T$   
 (b) A rectangular pulse of duration  $T$   
 (c) A triangular pulse of duration  $2T$   
 (d) A triangular pulse of duration  $T$

**Q.7** In connection with properties of the Fourier transform, match **List-I (Function of Time)** with **List-II (Spectral Density Function)** and select the correct answer using the code given below the lists:

**List-I**

**List-II**



**Codes:**

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 1 | 3 | 2 | 4 |
| (b) | 2 | 1 | 4 | 3 |
| (c) | 1 | 3 | 4 | 2 |
| (d) | 2 | 1 | 3 | 4 |

**Q.8** Match **List-I (Operations on  $x(t)$ )** with **List-II ( $X(\omega)$ /Fourier transform)** and select the correct answer using the codes given below the lists:

**List-I**

**List-II**

- A.** Time shift      **1.**  $\frac{1}{j\omega} X(\omega) + \pi X(0) \delta(\omega)$
- B.** Time differentiation      **2.**  $e^{-j\omega t_0} X(\omega)$
- C.** Time integration      **3.**  $X(\omega - \omega_0)$
- D.** Frequency shift      **4.**  $(j\omega)^n X(\omega)$

Codes:

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 1 | 4 | 3 |
| (b) | 2 | 4 | 1 | 3 |
| (c) | 3 | 4 | 1 | 2 |
| (d) | 3 | 1 | 4 | 2 |

**Q.9** Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

**List-I**

- A. Transmitter  
B. Fourier series  
C. Spectrum analyzer  
D. Compression

**List-II**

- For displaying signals in frequency domain.
- Provides more gain for low-level than for higher-level signals.
- Converts an information signal into a form suitable for propagation along a channel.
- Represents periodic functions as a series of sinusoids.

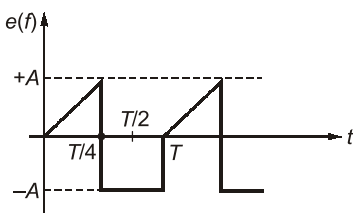
Codes:

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 1 | 2 | 4 | 3 |
| (b) | 3 | 4 | 1 | 2 |
| (c) | 3 | 1 | 4 | 2 |
| (d) | 1 | 4 | 2 | 3 |

**Q.10** A signal has Fourier series coefficients  $C_n \Rightarrow C_{-1} = C_1 = 8, C_0 = 0, C_2 = C_{-2} = 2$  its power is

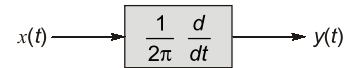
- (a) 0 (b) 136  
(c) 20 (d) 120

**Q.11** The rms value of the periodic waveform  $e(t)$  shown in figure is



- (a)  $\sqrt{\frac{3}{2}} A$  (b)  $\sqrt{\frac{2}{3}} A$   
(c)  $\sqrt{\frac{1}{3}} A$  (d)  $\sqrt{\frac{5}{6}} A$

**Q.12** A deterministic signal  $x(t) = \cos 2\pi t$  is passed through a differentiator as shown in figure.



what is its output power spectral density  $S_{yy}(f)$ ?

- (a)  $\frac{1}{4}[\delta(f-1) + \delta(f+1)]$   
(b)  $\frac{1}{4}[\delta(f-1) + \delta(f)]$   
(c)  $\frac{1}{4}[\delta(f) + \delta(f+1)]$   
(d) None of the above

**Q.13** The Fourier transform of  $x(t) = \frac{2a}{a^2 + t^2}$  is

- (a)  $2\pi e^{-a|\omega|}$  (b)  $\pi e^{-2a|\omega|}$   
(c)  $\pi e^{-a\omega}$  (d)  $\pi e^{-2a\omega}$

**Q.14** Consider the signal defined by

$$x(t) = \begin{cases} e^{j10t} & \text{for } |t| \leq 1 \\ 0 & \text{for } |t| > 1 \end{cases}$$

Its fourier transform is

- (a)  $\frac{2\sin(\omega-10)}{\omega-10}$  (b)  $2e^{j10} \frac{\sin(\omega-10)}{\omega-10}$   
(c)  $\frac{2\sin\omega}{\omega-10}$  (d)  $e^{j10\omega} \frac{2\sin\omega}{\omega}$

**Q.15** The Fourier series coefficients, of a periodic signal

$$x(t) \text{ expressed as } \sum_{k=-\infty}^{k=+\infty} a_k e^{j2\pi kt/T} \text{ are given by}$$

$$a_{-2} = 2 - j1; a_{-1} = 0.5 + j0.2; a_0 = j2; a_1 = 0.5 - j0.2; a_2 = 2 + j1; \text{ and } a_k = 0; \text{ for } |k| > 2$$

which of the following is true?

- (a)  $x(t)$  has finite energy because only finitely many coefficients are non-zero  
(b)  $x(t)$  has zero average value because it is periodic  
(c) the imaginary part of  $x(t)$  is constant  
(d) the real part of  $x(t)$  is even

**Q.16** Let  $x(t)$  be a signal with its Fourier transform  $X(j\omega)$  suppose we are given the following facts.

- $x(t)$  is real.
- $x(t) = 0$  for  $t \leq 0$ .

**Answers** Fourier Analysis of Signals, Energy and Power Signals

1. (a) 2. (b) 3. (c) 4. (d) 5. (c) 6. (c) 7. (b) 8. (b) 9. (b)  
 10. (b) 11. (d) 12. (d) 13. (a) 14. (a) 15. (a) 16. (d) 17. (b) 18. (b)  
 19. (b) 20. (d) 21. (a) 22. (d)

**Explanations** Fourier Analysis of Signals, Energy and Power Signals**1. (a)**

$$x(t) \longleftrightarrow a_k$$

$$x(t) = R_c(x(t)) + jI_m(x(t))$$

$$x^*(t) = R_c(x(t)) - jI_m(x(t))$$

$$x(t) \longleftrightarrow a_k$$

$$x^*(t) \longleftrightarrow a_k^*$$

$$x(t) + x^*(t) \longleftrightarrow a_k + a_k^*$$

$$2R_c(x(t)) \longleftrightarrow a_k + a_k^*$$

$$R_c(x(t)) \longleftrightarrow \frac{a_k + a_k^*}{2}$$

**2. (b)**

Function, $g(t)$	Fourier Transform, $G(f)$
Real and odd	Imaginary and odd
Real and even	Real and even
Imaginary and odd	Real and odd
Imaginary and even	Imaginary and even

**3. (c)**

Amplitude spectrum of Gaussian pulse is Gaussian.

**4. (d)**

$$\text{Sgn}(t) = \begin{cases} 1 & t > 0 \\ -1 & t < 0 \end{cases}$$

$$\text{Sgn}(t) = 2u(t) - 1$$

**5. (c)**

Signal is odd,  $x(t) = -x(-t)$   
 Signal is half symmetric

$$x(t) = x\left(t + \frac{T_0}{2}\right)$$

$\therefore$  contains odd harmonic.

Signal  $f(t)$  is real and odd,

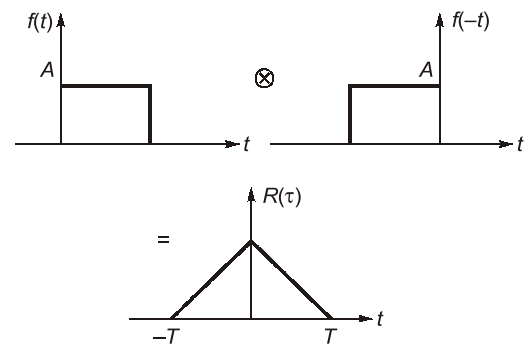
$\therefore F(\omega)$  is imaginary and odd.

**6. (c)**

Autocorrelation,

$$R(\tau) = f(t) \otimes f(-t) = \int_{-\infty}^{\infty} f(t) \cdot f(t - T) dt$$

i.e. convolution with the inverted version of signal itself.

**7. (b)**

$$F[e^{-at}u(t)] = \frac{1}{\sqrt{a^2 + \omega^2}} e^{-j \tan^{-1} \frac{\omega}{a}}$$

$$F[u(t)] = \pi \delta(\omega) + \frac{1}{j\omega}$$

$$F[\cos \omega_0 t] = \pi \delta(\omega - \omega_0) + \pi \delta(\omega + \omega_0)$$

$$F[\sin \omega_0 t] = j\pi [\delta(\omega - \omega_0) - \delta(\omega + \omega_0)]$$

**8. (b)**

Operation	$x(t)$	$X(\omega)$ /Fourier transform
• Time shift	$x(t - t_0)$	$e^{-j\omega t_0} X(\omega)$
• Time differentiation	$\frac{d^n x(t)}{dt^n}$	$(j\omega)^n X(\omega)$
• Time integration	$\int_{-\infty}^t x(\tau) d\tau$	$\frac{1}{j\omega} X(\omega) + \pi X(0) \delta(\omega)$
• Frequency shift	$x(t) e^{j\omega_0 t}$	$X(\omega - \omega_0)$

**10. (b)**

$$\begin{aligned} \text{Power} &= \sum_{n=-\infty}^{\infty} |C_n|^2 = \frac{1}{T} \int_{-T/2}^{T/2} |f(t)|^2 dt \\ &= |C_{-2}|^2 + |C_2|^2 + |C_1|^2 + |C_{-1}|^2 + |C_0|^2 \\ &= 2^2 + 2^2 + 8^2 + 8^2 + 0^2 = 136 \end{aligned}$$

**11. (d)**

$$V_{rms} = \sqrt{\frac{1}{T} \int_{-T/2}^{T/2} (f(t))^2 dt}$$

$$V_{rms}^2 = \frac{1}{T} \cdot \left[ \int_0^{T/4} \left( \frac{4A}{T} \cdot t \right)^2 dt + \int_{+T/4}^T (-A)^2 dt \right]$$

$$V_{rms}^2 = \frac{1}{T} \cdot \left[ \frac{3A^2 T}{4} + \frac{16A^2}{T^2} \cdot \frac{1}{3} \cdot \frac{T^3}{16 \times 4} \right]$$

$$V_{rms}^2 = A^2 \left[ \frac{3}{4} + \frac{1}{12} \right] = A^2 \cdot \frac{10}{12}$$

$$V_{rms} = A \sqrt{\frac{5}{6}}$$

**12. (d)**

$$S_0 = S_i(\omega) \cdot |H(\omega)|^2$$

$$H(\omega) = \frac{j\omega}{2\pi} = \frac{j2\pi f}{2\pi} = jf$$

$$|H(\omega)|^2 = \frac{\omega^2}{4\pi^2} = f^2$$

$$S_i(f) = \frac{1}{2} \cdot [\delta(f-1) + \delta(f+1)]$$

$$S_0(f) = \frac{f^2}{2} \cdot [\delta(f-1) + \delta(f+1)]$$

We know,

$$f^2 \cdot \delta(f-1) = (+1)^2 \cdot \delta(f-1)$$

$$f^2 \cdot \delta(f+1) = (-1)^2 \cdot \delta(f+1)$$

$$S_0(f) = \frac{1}{2} (\delta(f-1) + \delta(f+1))$$

**13. (a)**

$$e^{-a|t|} \longleftrightarrow \frac{2a}{a^2 + \omega^2}$$

Using duality property

$$\frac{2a}{a^2 + t^2} \longleftrightarrow 2\pi e^{-a|\omega|} = 2\pi e^{-a|\omega|}$$

**14. (a)**

$$X(\omega) = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$$

$$x(t) = \begin{cases} e^{j10t} & |t| < 1 \\ 0 & |t| > 1 \end{cases}$$

$$\Rightarrow X(\omega) = \int_{-1}^1 e^{j10t} \cdot e^{-j\omega t} dt$$

$$X(\omega) = \frac{e^{-j(\omega-10)} - e^{j(\omega-10)}}{-j(\omega-10)}$$

$$X(\omega) = \frac{2[e^{j(\omega-10)} - e^{-j(\omega-10)}]}{2j(\omega-10)}$$

$$X(\omega) = \frac{2 \sin(\omega-10)}{\omega-10}$$

**15. (a)**

$$a_{-2} = 2 - j1$$

$$a_2 = 2 + j1$$

$$\Rightarrow a_2 = a_{-2}^*$$

$$a_1 = 0.5 - j0.2$$

$$a_{-1} = 0.5 + j0.2$$

$$\Rightarrow a_1 = a_{-1}^*$$

Thus,  $x(t)$  is real.

Energy,

$$\int |x(t)|^2 dt = T \cdot \sum |C_n|^2$$

$$= T \sum |a_k|^2$$

$$= T(5 + 5 + 4 + 0.29 + 0.29)$$

$$= 14.58 T$$

For periodic signal,  $T$  is fixed,  
Hence energy is finite.

**16. (d)**

$$x(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} X(j\omega) e^{j\omega t} d\omega$$

$$\Rightarrow \text{Real}(x(t)) = 2|t| e^{-|t|}$$

Since,  $x(t) = 0, \quad t \leq 0$

$$\Rightarrow x(t) = 2te^{-t} \quad t > 0$$

$$-2te^t = 0, \quad t < 0$$

$$\Rightarrow x(t) = 2t e^{-t} u(t)$$

**17. (b)**

$$g(t) \longleftrightarrow G(\omega)$$

$$g(-t) \longleftrightarrow G(-\omega)$$

As,  $t \rightarrow t+1$

$$g(-t-1) \longleftrightarrow G(-\omega) e^{j\omega}$$

We know,  $G(\omega) = \frac{1}{\omega^2} (e^{j\omega} - j\omega e^{j\omega} - 1)$

# **MICROPROCESSORS**

## **OBJECTIVE PRACTICE SETS**

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# Introduction to 8085 and its Functional Organisation

- Q.1** Microprocessor 8085 is the enhanced version of \_\_\_\_\_ with essentially the same construction set.
- (a) 6800                      (b) 68000  
(c) 8080                      (d) 8000
- Q.2** The data bus in 8080A / 8085 microprocessor is a group of
- (a) eight bit bidirectional lines that are used to transfer 8 bits data between the microprocessor and its I/O and memory  
(b) eight lines used to transfer data among the registers  
(c) eight unidirectional lines that are used for I/O devices  
(d) sixteen bidirectional lines that are used for data transfer between the microprocessor and memory
- Q.3 Assertion (A):** The development of a microprocessor based product requires the design of program and the hardware.  
**Reason (R):** The design effort for an electronic product follows the same basic steps used in the development of software.
- (a) Both A and R are true and R is the correct explanation of A  
(b) Both A and R are true but R is NOT the correct explanation of A  
(c) A is true but R is false  
(d) A is false but R is true
- Q.4** The output data lines of microprocessors and memories are usually tristated, because
- (a) More than one device can transmit information over the data bus by enabling only one device at a time  
(b) More than one device can transmit information over the data bus at the same time  
(c) The data lines can be multiplexed for both input and output  
(d) It increases the speed of data transfers over the data bus
- Q.5** Machine instructions are written using which of the following?
- (a) Bits 0 and 1 only  
(b) Digits 0 to 9 only  
(c) Digits 0 to 9 and the capital alphabets A to Z only  
(d) Digits 0 to 9, the capital alphabets A to Z and certain special characters
- Q.6 Assertion (A):** Many programmes prefer assembly level programming to machine language programming.  
**Reason (R):** It is possible to efficiently utilise the hardware of the computer in machine language programming.
- (a) Both A and R are true, and R is the correct explanation of A.  
(b) Both A and R are true, but R is not a correct explanation of A.  
(c) A is true, but R is false.  
(d) A is false, but R is true.
- Q.7** Which one of the following statements is correct? A microcontroller differs from a microprocessor in that it has
- (a) both on-chip memory and on-chip ports.  
(b) only on-chip memory but not on-chip ports.  
(c) only on-chip ports but not on-chip memory.  
(d) neither on-chip memory nor on-chip ports.
- Q.8** What is the function of a program counter in an 8-bit microprocessor?
- (a) To store the op-code of the instruction being executed  
(b) To store the op-code of the next instruction  
(c) To store the address of the instruction being executed  
(d) To store the address of the next instruction
- Q.9** When an application is designed using a microcontroller it has the following advantages over a design based on a microprocessor :

1. Its chip count is less.
2. It is more fault tolerant.
3. It is cheaper.

Which of these are correct?

- (a) 1, 2 and 3                      (b) 1 and 2 only  
(c) 1 and 3 only                    (d) 2 and 3 only

- Q.10** An 'Assembler' in a microprocessor is used for
- (a) assembly of processors in a production line
  - (b) creation of new programs using different modules
  - (c) translation of a program from assembly language to machine language
  - (d) translation of a higher level language into English text

- Q.11** What is the direction of control bus?
- (a) Unidirectional into microprocessor
  - (b) Unidirectional out of microprocessor
  - (c) Bidirectional
  - (d) Mixed direction i.e. some lines into microprocessor and some lines out of microprocessor

- Q.12** Which one of the following statements is correct?  
A microprocessor program written in assembly language is translated into machine language. The number of instructions in the machine language when compared with the number of instructions in assembly language is
- (a) More only                      (b) Same
  - (c) Less only                      (d) Either more or less

- Q.13** The synchronisation between microprocessor and memory is done by
- (a) ALE signal                      (b) HOLD signal
  - (c) READY signal                (d) None of these

- Q.14** The stack pointer in the 8085 microprocessor is a
- (a) 16 bit register that point to stack memory locations
  - (b) 16 bit accumulator
  - (c) memory location in the stack
  - (d) flag register used for the stack

- Q.15** Consider the following registers:
1. Accumulator and B register
  2. B and C registers
  3. D and E registers
  4. H and L registers
- Which of these 8-bit registers of 8085  $\mu$ P can be paired together to make a 16-bit register?
- (a) 1, 3 and 4                      (b) 2, 3 and 4
  - (c) 1 and 2                        (d) 1, 2 and 3

- Q.16** In 8085 microprocessor, the value of the most significant bit of the result following the execution of any arithmetic or Boolean instruction is stored in the
- (a) carry status flag
  - (b) auxiliary carry status flag
  - (c) sign status flag
  - (d) zero status flag

- Q.17 Statement (I):** On executing the HLT instruction, the microprocessor enters into a halt state and all the buses are tri-stated.

**Statement (II):** On executing the HLT instruction, the microprocessor is disconnected from the system bus till the reset is pressed.

- (a) Both Statement I and Statement II are individually true and Statement II is the correct explanation of Statement I
- (b) Both Statement I and Statement II are individually true but Statement II is not the correct explanation of Statement I
- (c) Statement I is true but Statement II is false
- (d) Statement I is false but Statement II is true

- Q.18 Statement (I):** In an 8085 microprocessor, an input port and an output port can have same port address.

**Statement (II):**  $\overline{RD}$  is used to enable the input port and  $\overline{WR}$  is used to enable the output port.

- Q.19** Match List-I with List-II and select the correct answer using the codes given below the lists:

**List-I**

- A. Monitor program
- B. Assembler
- C. Mnemonic
- D. Program counter

**List-II**

1. Used to indicate memory location
2. A combination of letters, symbols and numerals
3. A program that translates symbolic instructions into binary equivalent
4. An operating system

**Codes:**

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 3 | 2 | 1 |
| (b) | 4 | 3 | 1 | 2 |
| (c) | 3 | 4 | 1 | 2 |
| (d) | 3 | 4 | 2 | 1 |

**Answers Introduction to 8085 and its Functional Organisation**

1. (c) 2. (a) 3. (b) 4. (a) 5. (a) 6. (a) 7. (a) 8. (d) 9. (a)  
 10. (c) 11. (d) 12. (b) 13. (c) 14. (a) 15. (b) 16. (c) 17. (a) 18. (a)  
 19. (a) 20. (b) 21. (a) 22. (d) 23. (b) 24. (a) 25. (c) 26. (b) 27. (19)  
 28. (7) 29. (400) 30. (36)

**Explanations Introduction to 8085 and its Functional Organisation**

**1. (c)**

8085 is advanced version of Intel 8080.

**2. (a)**

Data bus is of 8-bits and bidirectional and transfer data between microprocessor and memory/IO.

**4. (a)**

The output data lines of microprocessor and memories are tristate because more than one device can transmit information over the data bus by enabling only one device at a time.

**5. (a)**

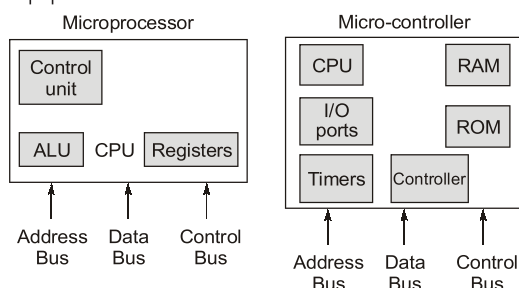
A programme written with 0's and 1's is called machine language programme. However sometime to facilitate programmer, machine code can be written in hexadecimal numbers.

**6. (a)**

Assembly language programmes are written in mnemonics with word like ADD for addition. It is convenient and easy as compared to machine language written in binary codes or in hexadecimal. Machine language is faster as it is the language of microprocessor. It is written in 1's and 0's e.g. in 8085 to add contents of register A and register B, binary code is 10000000. So, time and resources required for conversion of assembly language into machine code is saved. Hence it uses hardware efficiently.

**7. (a)**

Microcontroller has on-chip memory as well as on chip ports.



**8. (d)**

It is used to store 16-bit address of the next byte to be fetched from memory or address of the next instruction to be executed.

**9. (a)**

A microcontroller is an embedded system with some specific functions like vending machine, electronic parking meters. The processor has to perform simple and low grade computational functions. So the process is simple and cheaper. Its chip count i.e. number of chips circuitry is less. A microcontroller is put into function once and the system where it is used is rugged. No changes or complexities are required. It is immune to virus attacks. So it is more to be fault tolerant.

**10. (c)**

An 'Assembler' is used for translation of a program from assembly language to machine language.

**11. (d)**

Control bus have some lines into microprocessor and some out of microprocessor.

**12. (b)**

A program written in assembly language is translated into machine language. Number of instructions in assembly and machine language is same.

**13. (c)**

READY is an active high pin used to interface slow peripheral devices with 8085.

**14. (a)**

Stack pointer is of 16-bit register and it points to the stack memory locations and generally used in case of interrupt or PUSH, POP instructions.