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# POSTAL BOOK PACKAGE 2027

# ELECTRONICS ENGINEERING

## OBJECTIVE PRACTICE SETS VOLUME - III

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# MICROPROCESSORS

## OBJECTIVE PRACTICE SETS

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# 1 CHAPTER
# 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 μP 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)**

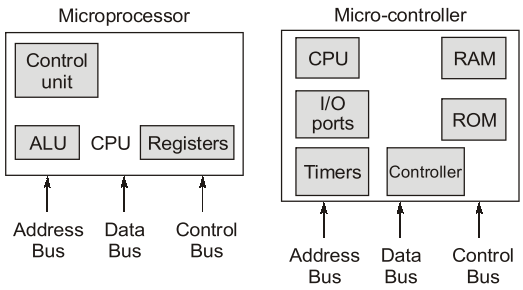
A programme written with 0's and 1's is called machine language programme. However sometime to facilitate programmer, machine code can be written in hexadecimal numbers.

**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 is 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.

**15. (b)**

Register pairs are BC, DE and HL,

**16. (c)**

MSB is stored in sign flag.

**17. (a)**

Reason is correct explanation of assertion.

**18. (a)**

Reason is correct explanation of assertion as with the help of $\overline{RD}$ and $\overline{WR}$ we can differentiate between input and output ports.

**19. (a)**

**Program counter:** Indicates memory location to which next instruction to be fetched.

**Monitor program:** An operating system.

**Assembler:** Converts machine language to binary equivalent.

**20. (b)**

TRAP ⇒ Both Level and Edge - sensitive
RST 7.5 ⇒ Edge - sensitive
RST 6.5 ⇒ Level - sensitive
RST 5.5 ⇒ Level - sensitive

**21. (a)**

The following actions are performed by 8085 RESET instruction.

- PC contents become 0000 H
- IR contents become 00 H
- All interrupts are disabled except TRAP.

**22. (d)**

**In memory mapped I/O:**
I/O devices have 16-bit addresses and arithmetic and logic operations can be directly performed in I/O data for memory mapped I/O.

**While I/O mapped I/O:** I/O devices can be accessed using IN-OUT instruction and maximum 256 input devices and 256 output devices can be there.

**23. (b)**

A. SID - Serial input data, SOD - Serial output data } Serial data transfer
B. Ready - Wait state
C. TRAP - Hardware interrupt
D. ALE - Address latch enable control

**24. (a)**

RST 7.5 → 003CH
RST 6.5 → 0034H
RST 5.5 → 002CH

**25. (c)**

**Priority order:**
TRAP > RST 7.5 > RST 6.5 > RST 5.5 > INTR

**26. (b)**

At a time 8085 can drive only a digit. In a second, each digit is refreshed 500 times. Thus time given to each digit

$$= \frac{1}{(5 \times 500)} = 0.4 \text{ ms}$$

**27. (19)**

Given: Memory chip $8192 \times 32 = 2^{13} \times 32$
$\therefore$ 13 address lines and 32 data lines
$\therefore \quad q - p = 32 - 13 = 19$

**28. (7)**

$$0038\,H = (56)_{10}$$
$$n \times 8 = 56$$
$$n = 7$$

**29. (400)**

$$f_{Clock} = \frac{1}{2} \times \text{Crystal frequency}$$
$$= \frac{1}{2} \times 5 = 2.5 \text{ MHz}$$
$$T = \frac{1}{f_{Clock}} = \frac{1}{2.5} \mu s$$
$$= 0.4\ \mu s = 400 \text{ ns}$$

**30. (36)**

TRAP (RST 4.5) is both edge as well as level sensitive. Its vector address is $(36)_{10}$.

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# MATERIALS SCIENCE

## OBJECTIVE PRACTICE SETS

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# 1 CHAPTER

Materials Science

# Introduction to Engineering Materials

**Q.1** A unit cell is
(a) an agglomerated structure.
(b) the basic building block of crystal.
(c) the smallest group of atoms which when regularly repeated forms the crystal.
(d) 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.
(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.3** Consider the following statements:
1. The crystal directions of a family must be parallel to one another.
2. Crystal directions and crystal plane are denoted by the Miller indices.
3. In cubic crystals, a crystal plane and a crystal direction normal to it have different indices.
4. 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?
(a) 2, 3 and 4 (b) 2 and 4
(c) 1, 2 and 3 (d) 4 only

**Q.4** Consider the following statements associated with the atomic structure and chemical bonding:
1. Covalent bond is non-directional.
2. The metallic bond is directional and generally weaker than ionic and covalent bonds.
3. Free electrons are responsible for the high thermal and electrical conductivities of metals.
4. 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?
(a) 2, 3 and 5 (b) 1, 2 and 4
(c) 3, 4 and 5 (d) 1, 3 and 5

**Q.5** The Miller indices of a plane are proportional to
(a) the reciprocal of numerical parameters of the intercepts
(b) the square of unit cell dimensions
(c) the intercepts of the planes on the coordinate axes
(d) 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?
(a) (3, 1, 6) (b) (6, 3, 1)
(c) (1, 3, 6) (d) (3, 6, 1)

**Q.7** The atomic diameter of an FCC crystal (lattice parameter is $a$) is
(a) $\frac{a\sqrt{2}}{2}$ (b) $\frac{a\sqrt{2}}{4}$
(c) $\frac{a\sqrt{3}}{4}$ (d) $\frac{a}{2}$

**Q.8** A material is most stable when its potential energy is
(a) maximum (b) infinite
(c) minimum (d) 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
(a) atomic number of the solid
(b) half the number of atoms in the solid
(c) the number of atoms in the solid
(d) twice the number of atoms in the solid

**Q.10** Consider the following statements:
Secondary (or Molecular) bonds are
1. 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) $a = b = c$, $\alpha = \beta = \gamma \neq 90°$.
(b) $a = b \neq c$, $\alpha = \beta = 90°$, $\gamma = 120°$.
(c) $a \neq b \neq c$, $\alpha = \gamma = 90° \neq \beta$.
(d) $a \neq b \neq c$, $\alpha \neq \beta \neq \gamma \neq 90°$.

**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 $$r = \frac{c_3}{c} = \frac{3c}{c} = 3$$

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

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

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)**

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

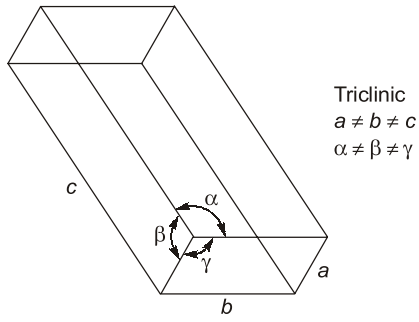
$$a = \left(\frac{nM}{N\rho}\right)^{1/3}$$

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)**




**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.

# ELECTRONIC MEASUREMENTS & INSTRUMENTATION

## OBJECTIVE PRACTICE SETS

Page No. 84 - 151

# 1 CHAPTER

# Introduction

**Q.1** The difference between the indicated value and the true value of a quantity is
(a) Gross error (b) Absolute error
(c) Dynamic error (d) Relative error

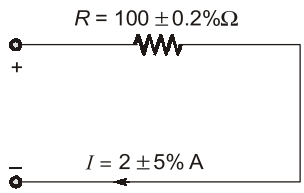
**Q.2** Consider the following statements regarding "precision" of an instrument:
1. Precision is a measure of the degree of agreement within a group of measurements.
2. Precision is necessary, but not sufficient condition for accuracy.

Which of the above statements is/are correct?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

**Q.3** A 0 to 200 V voltmeter has a guaranteed accuracy of 1% of full scale reading. The voltage measured by this instrument is 50 V. What is the limiting error?
(a) 4% (b) 2%
(c) 1% (d) 0.25%

**Q.4** Two meters *X* and *Y* require 40 mA and 50 mA, respectively, to give full-scale deflection, then
(a) sensitivity can not be judged with given information.
(b) both are equally sensitive.
(c) *X* is more sensitive.
(d) *Y* is more sensitive.

**Q.5** In the circuit given in the figure, the limiting error in the power dissipation '$I^2R$' across the resistor *R* is




(a) 1.2% (b) 5.2%
(c) 10.2% (d) 25.2%

**Q.6** The dead zone in a pyrometer is 0.125% of span. The instrument is calibrated from 500°C to 2000°C. What temperature range must occur before it can be detected in degree centigrade _____.

**Q.7** A voltmeter reading 70 V on its 100 V range and an ammeter reading of 80 mA on its 150 mA range are used to determine power dissipation in a resistor. Both these instruments are guaranteed to be accurate within ±2% at full scale deflection. The limiting error (in percentage) in power measurement is _____ .
(Answer upto one decimal place)

**Q.8** A first order instrument is characterized by
(a) Time constant only
(b) Static sensitivity and time constant
(c) Static sensitivity and damping coefficient
(d) Static sensitivity and time constant and natural frequency of oscillations

**Q.9** A resistance of 108 Ω is specified using significant figures as indicated below:
1. 108 Ω
2. 108.0 Ω
3. 0.000108 MΩ

Among these:
(a) 1 represents greater precision than 2 and 3
(b) 2 represents greater precision but 1 and 3 represents same precision
(c) 2 and 3 represent greater precision than 1
(d) 1, 2 and 3 represent the same precision

**Q.10** Match **List-I** (Accuracy) with **List-II** (Type of the standard) and select the correct answer:

| List-I | List-II |
|---|---|
| A. Least accurate | 1. Primary |
| B. More accurate | 2. Secondary |
| C. Much more accurate | 3. Working |
| D. Highest possible accurate | 4. International |

Codes:

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

**Q.11** **Assertion (A):** Random errors can be minimized by statistical methods.
**Reason (R):** These are caused by arithmetic error while taking readings.
(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.12** The following is not essential for the working of an indicating instrument
(a) deflecting torque (b) braking torque
(c) damping torque (d) controlling torques

**Q.13** **Assertion (A):** Damping torque is used to bring the pointer to the zero initial position if there is not deflecting torque.
**Reason (R):** Eddy current damping is preferred for the applications requiring high magnetic field.
(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.14** Which one of the following is the definition of the dead zone of an instrument?
(a) The time required by an instrument to warm up initially.
(b) The largest change of input quantity for which there is no output of the instrument.
(c) The time required by the instrument to begin to respond to a change in the measurement.
(d) The unmeasured quantity which exceeds the maximum range of the instrument.

**Q.15** During measurement in a college laboratory, nine different set of readings were observed. The standard deviation and variance can be calculated respectively using:
(a) $\sqrt{\frac{\Sigma d^2}{9}}, \frac{\Sigma d^2}{9}$ (b) $\sqrt{\frac{\Sigma d^2}{8}}, \frac{\Sigma d^2}{9}$
(c) $\sqrt{\frac{\Sigma d^2}{8}}, \frac{\Sigma d^2}{8}$ (d) $\sqrt{\frac{\Sigma d^2}{9}}, \frac{\Sigma |d|}{9}$

**Q.16** Consider the following:
1. Human errors
2. Improper application of instruments
3. Error due to worn parts of an instrument
4. Errors due to effects of environment

Which of the above come under the type of systematic errors?
(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 2 and 3 (d) 1, 2 and 4

**Q.17** Four ammeters M1, M2, M3 and M4 with following specifications are available (Full scale accuracy values as a percent of full scale). $M_1 = 20 \pm 0.1$, $M_2 = 10 \pm 0.2$, $M_3 = 5 \pm 0.5$ and $M_4 = 1 \pm 1$. A current of 1 A is to be measured to obtain minimum error in the reading which meter should be chosen.
(a) $M_1$ (b) $M_2$
(c) $M_3$ (d) $M_4$

**Q.18** The following measurement are obtained on a single-phase load: $V = 220\text{ V} \pm 2\%$, $I = 10\text{ A} \pm 1\%$ and $P = 500\text{ W} \pm 2\%$. If the power factor is calculated using these measurements, the worst case error in the calculated power factor in percentage is _____ (Answer upto 1 decimal place)

**Q.19** A utility type voltmeter with an accuracy of ±3% of full scale (at 25°C) is used on 300 V scale to measure 230 V.
(a) What is the possible percentage limiting error?
(b) What range will the actual voltage fall within if the instrument reads 200 V?
(a) 3.9%, 196-204 V (b) 3.9%, 191-209 V
(c) 7.6%, 221-239 V (d) 7.6%, 195-204.5 V

**Q.20** Which one of the following is the most stable frequency primary atomic standard for frequency?
(a) Caesium beam standard
(b) Hydrogen maser standard
(c) Rubidium vapour standard
(d) Quartz crystal standard

**Q.31** Consider the following properties of any measurement system:

1. Fidelity
2. Reproductibility
3. Lag
4. Dead zone

Which of these are both dynamic and undesirable characteristics of a measurement system?

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

**Q.32** A 4 dial decade box has
Decade a of 10 × 1000 Ω ± 0.2%
Decade b of 10 × 100 Ω ± 0.1%
Decade c of 10 × 10 Ω ± 0.5%
Decade d of 10 × 1 Ω ± 2%
It the setting is at 8172 Ω. Then range of resistance value is

(a) (8165.5 to 8178.5) Ω
(b) (8159.5 to 8184.5) Ω
(c) (8155.5 to 8188.5) Ω
(d) None of these

■■■■

## Answers Introduction

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **1.** (b) | **2.** (c) | **3.** (a) | **4.** (c) | **5.** (c) | **6.** (1.875) | **7.** (6.6) | **8.** (b) | **9.** (b) |
| **10.** (c) | **11.** (c) | **12.** (b) | **13.** (c) | **14.** (b) | **15.** (c) | **16.** (b) | **17.** (d) | **18.** (5) |
| **19.** (b) | **20.** (a) | **21.** (b) | **22.** (a) | **23.** (1) | **24.** (1.956) | **25.** (b) | **26.** (b) | **27.** (d) |
| **28.** (b) | **29.** (a) | **30.** (c) | **31.** (b) | **32.** (c) | | | | |

## Explanations Introduction

**1. (b)**

- Absolute error = Measured/Indicating value – True value
- Relative error = $\frac{\text{Measured value} - \text{True value}}{\text{True value}}$

**2. (c)**

- Precision is a measure of reproductibility of measurements i.e. for a fixed value of variable, it is the measure of the degree to which successive measurements differ from one another.
- Precision is not sufficient condition for accuracy since precision of an instrument does not guarantee of the accuracy of the instrument.
- Precision is not the guarantee of accuracy.

**3. (a)**

Given, full scale reading = 200 V
Magnitude of limiting error of instrument is

$$= \frac{1}{100} \times 200 = 2 \text{ V}$$

$$\therefore \text{Relative limiting error} = \frac{2}{50} \times 100 = 4\%$$

**4. (c)**

- Sensitivity $\alpha$ $\frac{1}{\text{Deflection factor}}$
- Static sensitivity = $\frac{1}{I_{FSD}}$

Here $X$ have lower $I_{FSD}$ and hence $X$ is more sensitive meter.

**5. (c)**

$$P = I^2R$$

Limiting error is given as,

$$\frac{dP}{P}\% = 2\frac{dI}{I}\% + \frac{dR}{R}\%$$

$$= 2 \times 5\% + 0.2\% = 10.2\%$$

**6. Sol.**

$$\text{Span} = 2000\,^\circ\text{C} - 500\,^\circ\text{C}$$
$$= 1500\,^\circ\text{C}$$

$\therefore$ Temperature change

$$= \frac{0.125}{100} \times 1500$$
$$= 1.875\,^\circ\text{C}$$

**7. Sol.**

The magnitude of limiting error of the voltmeter = 0.02 × 100 = 2 V

Percentage limiting error at 70 V

$$= \frac{2}{70} \times 100 = 2.857\%$$

The magnitude of limiting error of the ammeter

= 0.02 × 150 mA = 3 mA

Percentage limiting error at 80 mA

$$= \frac{3}{80} \times 100 = 3.75\%$$

$P = VI$

Percentage limiting error in power measurement

= 2.857% + 3.75%

= 6.607% ≈ 6.6%

**8. (b)**

For first order instruments, transfer function is,

$$\text{T.F.} = \frac{K}{1+sT}$$

where, $K$ = static sensitivity

$T$ = time constant

**9. (b)**

1. 108 Ω has 3 significant figures.
2. 108.0 Ω has 4 significant figures.
3. 0.000108 MΩ can be written has 108 Ω.

So, it has 3 significant figures.

The more the significant figures, the greater the precision of measurement.

Hence, option (b) is correct.

**10. (c)**

- International standards represents the units of measurements which is closest of highest possible accuracy attainable.
- Order of accuracy:

International standards > Primary standards > Secondary standards > Working standards

**11. (c)**

Random errors or residual errors are computed using statistical methods. These errors are caused by the happenings or disturbances which we are unaware of. These are not caused by arithmetic error while taking readings. Hence, statement (II) is wrong.

**12. (b)**

Three types of forces are needed for the satisfactory operation of any indicating instrument. These are:

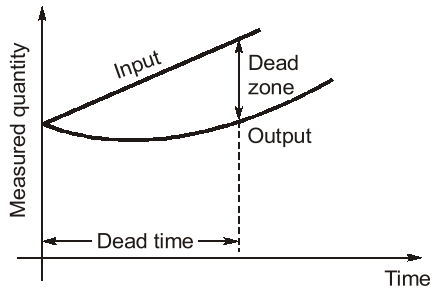
1. Deflecting force
2. Controlling force
3. Damping force

**13. (c)**

Damping torque is required to damp out the oscillation of pointer. It is the controlling torque ($T_c$) which bring the pointer to zero position for no deflection. Hence statement (A) is wrong.

**14. (b)**

In dead zone, there is no change in output, though input changes.




**15. (c)**

For $n = 9$ readings, $(n < 20)$

- Standard deviation = $\sigma = \sqrt{\frac{\Sigma d^2}{n-1}} = \sqrt{\frac{\Sigma d^2}{8}}$
- Variance = $V = \sigma^2 = \frac{\Sigma d^2}{8}$

**16. (b)**

- Systematic errors are classified as instrument errors, observation errors and environmental errors.
- Errors due to shortcoming in the instrument is instrument error.
- Also, due to effects of external environment, systematic errors occur. Hence, (2), (3) and (4) are correct.

**17. (d)**

$$\text{LE} = \frac{\text{GAE} \times \text{FSR}}{\text{Reading}}$$

where,

# MICROWAVE ENGINEERING

## OBJECTIVE PRACTICE SETS

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# 1 CHAPTER
# Introduction

**Q.1** A square waveguide carries $TE_{11}$ mode whose axial magnetic field is given by

$$H_z = H_0 \cos\frac{\pi x}{\sqrt{8}} \cos\frac{\pi y}{\sqrt{8}} \text{ A/m}$$

Where the waveguide dimensions are in centimeters. What is the cut-off frequency of the mode?

(a) 5 GHz (b) 7.5 GHz
(c) 6.5 GHz (d) 8 GHz

**Q.2** Match **List-I** (Transmission system) with **List-II** (Mode) and select the correct answer using the codes given below the lists:

| List-I | List-II |
|---|---|
| A. Rectangular waveguide | 1. TE/TM |
| B. Circular waveguide | 2. TEM |
| C. Coaxial Line | 3. Quasi-TEM |
| D. Microstrip Line | |

**Codes :**

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

**Q.3** In a hollow rectangular waveguide, the phase velocity

(a) Increases with increasing frequency.
(b) Decreases with decreasing frequency.
(c) Decreases with increasing frequency.
(d) Is independent of frequency.

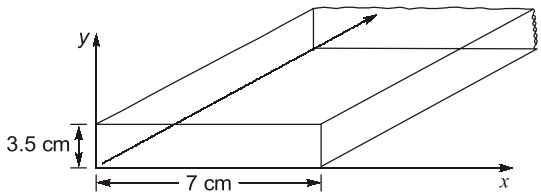
**Q.4** A rectangular or a circular waveguide is

(a) A resonant circuit
(b) High-pass filter
(c) Low pass filter
(d) None of the above

**Q.5** Typical microwave oven work on the frequency

(a) 1.225 GHz (b) 2.45 GHz
(c) 4.90 GHz (d) 9.80 GHz

**Q.6** An air-filled rectangular waveguide of inside dimensions 7 × 3.5 cm operates in the dominant $TE_{10}$ mode as shown in figure.




1. Find the cutoff frequency.
2. Determine the phase velocity of the wave in the guide at a frequency of 3.5 GHz

(a) 1.07 GHz, $3.78\times10^8$ m/s
(b) 2.14 GHz, $1.89\times10^8$ m/s
(c) 2.14 GHZ, $3.78\times10^8$ m/s
(d) 1.07 GHz, $1.89\times10^8$ m/s

**Direction for Q. 7, 8 and 9**

A lossless line has a characteristic impedance of 50 Ω and is terminated in a load resistance of 75 Ω. The line is energized by a generator which has an output impedance of 50 Ω and an open-circuit output voltage of 30 V(rms). The line is assumed to be 2.25 wavelengths long. Determine

**Q.7** The input impedance

(a) 100 Ω (b) 33.33 Ω
(c) 66.67 Ω (d) 50 Ω

**Q.8** The magnitude of the instantaneous load voltage.

(a) 0 V (b) 18 V
(c) 36 V (d) 42 V

**Q.9** The instantaneous power delivered to the load is

(a) $\left(30\sqrt{2}\right)^2$ (b) $\frac{(36)^2}{75}$
(c) $\frac{(18)^2}{75}$ (d) $\frac{(42)^2}{75}$

**Q.10** Consider the following statements about smith chart

1. The constant r and constant x circles all pass through the point ($G_r = 1$, $G_i = 0$).
2. The distance around the smith chart once is one-half wavelength (λ/2).

3. At a point of $Z_{min} = 1/\rho$, there is a $V_{min}$ on the line while a point of $Z_{max} = \rho$, there is a $V_{max}$ on the line.

(a) 1 only is correct (b) 2 only is correct
(c) 3 only is correct (d) 1, 2, 3 all are correct

**Q.11** Guide wavelength ($\lambda_g$), cut-off wavelength ($\lambda_c$) and free space wavelength ($\lambda_0$) of a waveguide are related as

(a) $\frac{1}{\lambda_g^2} = \frac{1}{\lambda_0^2} - \frac{1}{\lambda_c^2}$ (b) $\frac{1}{\lambda_0^2} = \frac{1}{\lambda_g^2} - \frac{1}{\lambda_c^2}$

(c) $\frac{1}{\lambda_c^2} = \frac{1}{\lambda_0^2} + \frac{1}{\lambda_g^2}$ (d) $\frac{1}{\lambda_g} = \frac{1}{\lambda_0} + \frac{1}{\lambda_c}$

**Q.12** A 75 Ω transmission line is first short terminated and the minima locations are noted. When the short is replaced by a resistive load $R_L$, the minima locations are not altered and the VSWR is measured to be 3.
What is the value of $R_L$?
(a) 25 Ω (b) 50 Ω
(c) 225 Ω (d) 250 Ω

**Q.13** It is necessary to propagate a 10 GHz signal in a waveguide whose wall separation is 6 cm. What is the greatest number of half-waves of electric intensity which it will be possible to establish between two walls (i.e., what is the largest value of m)?
(a) 1 (b) 2
(c) 3 (d) 4

**Q.14** In the question no -'13' calculate the guide wavelength for this mode of propagation.
(a) 2.27 cm (b) 4.54 cm
(c) 6.81 cm (d) 9.08 cm

**Q.15** What is the formula for the cut off wavelength in a standard rectangular waveguide for the $TM_{11}$ mode. Assume that standard rectangular waveguide has aspect ratio 2:1
(a) 0.447a (b) 1.341a
(c) 0.894a (d) 0.599a

**Q.16** For some applications circular waveguides may be preferred to rectangular ones because of
(a) The smaller cross section needed at any frequency
(b) Lower attenuation
(c) Freedom from spurious modes
(d) Rotation of polarizations

**Q.17** Which of the following antenna is best excited from a waveguide?
(a) Horn (b) Discone
(c) Helical (d) Biconical

**Q.18** Standard mismatching in microwave circuits have SWR from:
(a) 0.5 : 1 to 2 : 1 (b) 1 : 0 to 2 : 1
(c) 1.2 : 1 to 2 : 1 (d) 1 : 33 to 2 : 1

**Q.19** Waveguides are considered superior to coaxial lines in the range
(a) 30 MHz to 1 GHz
(b) 1 GHz to 3 GHz
(c) 3 GHz to 100 GHz
(d) 100 GHz to150 GHz

**Q.20** The following waveguide tuning component is not easily adjustable
(a) Stub (b) Iris
(c) Screw (d) Plunger

**Q.21** Which of the following is not true about the properties of TEM modes in a lossless medium.
(a) Its cutoff frequency is zero
(b) Its propagation constant is the constant in an unbounded dielectric
(c) Its phase velocity is the velocity of light in an unbounded dielectric
(d) None of these

**Q.22** A rectangular waveguide is designed to propagate the dominant mode $TE_{10}$ at a frequency of 5 GHz. The cut off frequency is 0.8 of signal frequency. The ratio of the guide height to width is 2. The dimensions of the guide are
(a) 3.75 cm, 1.875 cm
(b) 4 cm, 2 cm
(c) 8 cm, 4 cm
(d) 2.54 cm, 1.27 cm

**Q.23** The guide wavelength is measured by short-circuiting a waveguide and shifting the tunable probe along the slotted line to locate the voltage minima. If the shorting plate is replaced by a matched load, then
(a) it would improve the accuracy of the measurement.
(b) the guide wavelength cannot be measured.
(c) it will give less accurate result, as no reflected wave is present.
(d) it will change the value of the guide wavelength

**Q.36** When phase velocities of an EMW depends on frequency in any medium, the phenomenon is
(a) Scattering (b) Absorption
(c) Polarisation (d) Dispersion

**Q.37** For low attenuation, the best transmission medium is
(a) Flexible waveguide
(b) Ridged waveguide
(c) Rectangular waveguide
(d) Coaxial line

**Q.38** In order to reduce cross sectional dimensions, the waveguide to use it
(a) Circular (b) Ridged
(c) Rectangular (d) Flexible

**Q.39** Which transmission line is ideal for handling high powers?
(a) Coaxial line (b) Microstrip
(c) Stripline (d) Rectangular

**Q.40** Microwave energies propagate the length of the waveguide by ..... its side walls
(a) Reflection of (b) Refraction of
(c) Moving of (d) Absorbing

**Q.41** If the receiving antenna is polarised at 90° with respect to transmitting antenna it will receive
(a) No signal (b) Maximum signal
(c) Minimum signal (d) None of these

**Q.42** The velocity propagation in a coaxial waveguide is
(a) $v = \frac{c}{\alpha}$ (b) $v = \frac{c^2}{\alpha}$
(c) $v = \frac{c}{\alpha^2}$ (d) None of these

**Q.43** Waveguides are generally not used for
(a) < 1 GHz (b) < 10 GHz
(c) < 50 GHz (d) < 150 GHz

**Q.44** Wave guide are generally not made of
(a) Copper (b) Aluminium
(c) Bronze (d) All

**Q.45** Wave guides are considered superior to coaxial lines in the range
(a) 30 MHz - 1 GHz (b) 1 GHz - 3 GHz
(c) 3 GHz - 100 GHz (d) 100 GHz - 150 GHz

■■■■

**Answers** **Introduction**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1. (b) | 2. (a) | 3. (c) | 4. (b) | 5. (b) | 6. (c) | 7. (b) | 8. (c) | 9. (b) |
| 10. (d) | 11. (a) | 12. (c) | 13. (c) | 14. (b) | 15. (c) | 16. (b) | 17. (a) | 18. (c) |
| 19. (c) | 20. (b) | 21. (d) | 22. (a) | 23. (d) | 24. (a) | 25. (a) | 26. (c) | 27. (c) |
| 28. (b) | 29. (b) | 30. (b) | 31. (c) | 32. (a) | 33. (a) | 34. (b) | 35. (d) | 36. (c) |
| 37. (c) | 38. (b) | 39. (d) | 40. (a) | 41. (a) | 42. (b) | 43. (a) | 44. (a) | 45. (c) |

## Explanations Introduction

**1. (b)**

$$\lambda_c = \frac{2a}{\sqrt{m^2+n^2}}$$

$$= \frac{2a}{\left(\frac{1}{\sqrt{8}}\right)^2+\left(\frac{1}{\sqrt{8}}\right)^2} = 4 \text{ cm}$$

$$\therefore \quad f_c = \frac{c}{\lambda_c} = \frac{3\times10^8}{4\times10^{-2}} = 7.5 \text{ GHz}$$

**2. (a)**

Microstrip line → Quasi-TEM
Coaxial line → TEM

**3. (c)**

$$\text{Phase velocity} = \frac{c}{\sqrt{1-\left(\frac{f}{f_c}\right)^2}} = \frac{c}{1-\left(\frac{\lambda_c}{\lambda}\right)^2}$$

**4. (b)**

RWG : below certain cutoff frequencies it doesn't work, so we can say it acts like high pass filter.

**5. (b)**

Microwave oven : 2.45 GHz

**6. (c)**

$$f_c = \frac{c}{2a} = \frac{3\times10^8}{2\times7\times10^{-2}} = 2.14 \text{ GHz}$$

$$V_p = \frac{c}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}} = \frac{3\times10^8}{\sqrt{1-\left(\frac{2.14}{3.5}\right)^2}}$$

$$= 3.78 \times 10^8 \text{ m/sec}$$

**7. (b)**

$$Z_{in} = \frac{(50)^2}{75} = 33.33\ \Omega$$

**8. (c)**

$$\text{Reflection coefficient } \Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{75-50}{75+50}$$

then the instantaneous voltage at load

$$V = V^+ e^{-j\beta l}(1+\Gamma) \quad (\because l = 0)$$

$$= 30(1+0.2) = 36 \text{ V}$$

**9. (b)**

Instantaneous power delivered to load is

$$P = \frac{(36)^2}{75} = 17.28 \text{ W}$$

**11. (a)**

$$\frac{1}{\lambda^2} = \frac{1}{\lambda_g^2} + \frac{1}{\lambda_c^2}$$

**12. (c)**

$$\text{VSWR} = 3 = \frac{1+|\Gamma|}{1-|\Gamma|}$$

$$\Rightarrow \quad |\Gamma| = 0.5 = \frac{Z_L - Z_0}{Z_L + Z_0} \quad Z_0 = 75\ \Omega$$

$$\therefore \quad Z_L = 225\ \Omega$$

**13. (c)**

when $m = 1$, $\lambda = \frac{2\times6}{1} = 12$ cm ✓

when $m = 2$, $\lambda = \frac{2\times6}{2} = 6$ cm ✓

when $m = 3$, $\lambda = \frac{2\times6}{3} = 4$ cm ✓

when $m = 4$, $\lambda = \frac{2\times6}{4} = 3$ cm ×

for 10 GHz $\lambda = \frac{3\times10^8}{10\times10^9} = 3$ cm

$\therefore$ $m = 4$ is not allowed

**14. (b)**

$$\lambda_g = \frac{\lambda}{\sqrt{1-\left(\frac{\lambda}{\lambda_c}\right)^2}} = \frac{3}{\sqrt{1-\left(\frac{3}{4}\right)^2}} = 4.54 \text{ cm}$$

**15. (c)**

For aspect ratio 2 : 1 ⇒ $b = a/2$

$$\therefore \quad \lambda_0 = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2+\left(\frac{n}{b}\right)^2}} = \frac{2a}{\sqrt{m^2+4n^2}}$$

here $m = n = 1$

$$\therefore \quad \lambda_0 = \frac{2a}{\sqrt{5}} = 0.894\ a$$

**16. (b)**

RWG has high attenuation at low frequencies while CWG - lower attenuation.

**17. (a)**

For waveguide, horn antenna is used.

**18. (c)**

Standard mismatching in microwave circuits have VSWR - 1.2 : 1 - 2 : 1

**19. (c)**

Coaxial lines fail in microwave frequency range, because attenuation increases by a huge amount.

**20. (b)**

Iris is not easily adjustable in waveguide.

**21. (d)**

**TEM mode:**

Cutoff frequency is zero.

Propagation constant is constant.

Phase velocity = velocity of light.

Wave impedance = $\eta$(in free space)

Can't exist in hollow waveguide. Can exist only in two conductor system where centre conductor does not exist.

$E_z = H_z = 0$

**22. (a)**

$$f_c = 0.8\, f = 0.8 \times 5 = 4 \text{ GHz}$$

For $TE_{10}$

$$f_c = \frac{c}{2a} = \frac{3\times10^8}{2a} = 4 \times 10^9$$

$$a = \frac{3}{80}\times100\times10^{-2}$$

$$= 3.75 \text{ cm}$$

**23. (d)**

Theoretical.

**24. (a)**

In circular waveguide, $TM_{01}$ mode overcomes the problem of rotation of polarizations, also require small diameter.

**25. (a)**

At microwave frequencies, we talk of travelling waves with associated powers instead of voltages and current[S] parameters because at higher frequencies, matched terminations is easy rather than open circuit or short circuit.

**26. (c)**

Waveguide does not work below a certain frequency (High Pass Filter)

**27. (c)**

300 $\Omega$ twin lead : low loss, unshielded, balanced.

**28. (b)**

For microwave - distributed circuit elements.

**30. (b)**

Cutoff wavelength of $TM_{11}$ mode in circular waveguide

$$\lambda_c = \frac{\pi D}{3.83} = 0.82\, D$$

**31. (c)**

L $\rightarrow$ 1 - 2 GHz

S $\rightarrow$ 2 - 4 GHz

C $\rightarrow$ 4 - 8 GHz

X $\rightarrow$ 8 - 12 GHz

Ku $\rightarrow$ 12 - 16 GHz

K $\rightarrow$ 16 - 24 GHz

Ka $\rightarrow$ 24 - 40 GHz

**32. (a)**

Cutoff frequency

$$f_c = \frac{c}{\sqrt{\epsilon_r}\, 2a}$$

$$= \frac{3\times10^8}{2\times2\times1.5\times10^{-3}} = 5 \text{ GHz}$$

$\therefore$ 8 GHz signal will pass.

**33. (a)**

In evanescent mode - Propagation constant is purely real.

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