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ELECTRONICS ENGINEERING

CONVENTIONAL PRACTICE SETS VOLUME-III

CONTENTS

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MICROPROCESSORS

CONVENTIONAL PRACTICE SETS

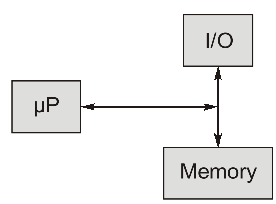
1 CHAPTER Introduction to 8085 and its Functional Organisation

Q.1 Explain what do you understand by microprocessor. List a few of its uses.

Solution:

Microprocessor is a programmable, clocked register based electronic device that reads binary instruction from its memory and does the processing over it.

Microprocessor is an electronic chip that has a computing and decision making capability. When this microprocessor is used as a CPU in a system, then it is called as a microcomputer.



Uses of microprocessor:

(i) Industrial PID controllers
(ii) Calculators
(iii) Data acquisition systems
(iv) Laptop and personal computers

Q.2 List the registers used in 8085.

Solution:

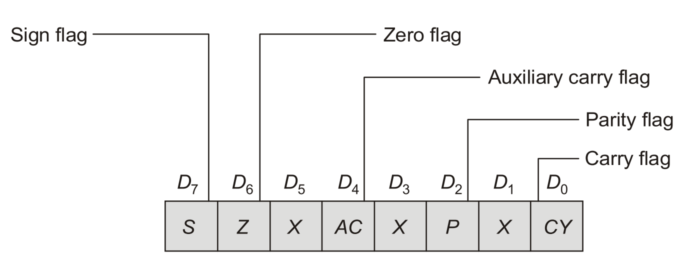
Registers are used in the microprocessor to store data temporarily during execution of program and may or may not be accessible to the users.

Important registers used in 8085 are:

(i) Accumulator (8-bit)
(ii) Register B (8-bit)
(iii) Register C (8-bit)
(iv) Register D (8-bit)
(v) Register E (8-bit)
(vi) Register H (8-bit)
(vii) Register L (8-bit)
(viii) Stack pointer (16-bit)
(ix) Program counter (16-bit)
(x) Flag register (8-bit)

Q.3 Describe the flags of 8085 microprocessor.

Solution:



8085 flag register

The 8085 microprocessor has 5 flags:

1. **Zero:** It is set to 1 when result is zero. Otherwise it is reset to zero.
2. **Carry:** If an arithmetic operations results in carry, it is set otherwise it is reset.
3. **Auxiliary carry:** In an arithmetic operation, when carry is generated by digit D_3 and passed to digit D_4, the AC flag is set.
4. **Parity:** If the result has an even number of 1's the flag is set, for an odd number of 1's the flag is reset.
5. **Sign:** It is set if MSB of the result is 1, otherwise it is reset.

Q.4 In 8085 microprocessor, what is the advantage of multiplexing the address bus with a data bus?

Solution:

Advantages of multiplexing the address bus with data bus are as follows:

1. Reduction in the number of pins required in the microprocessor. We save 8 pins at the cost of 1 ALE pin by using multiplexing.
2. Reduction in cost of microprocessor.
3. Reduction in space required by the microprocessor.
4. More efficient use of address bus since if it was used only for addressing, it would have remained idle for most of the T states.
5. Multiplexing address and data buses in the microprocessor allows for multiplexing in other peripheral devices as well without additional hardware. This results in a lot of cost + space saving for the whole circuit.

Q.5 Describe the various addressing modes in the microprocessor 8085. Give suitable examples for each addressing mode.

Solution:

1. **Immediate addressing mode:** In this mode, the 8/16 bit data is specified in the instruction itself as one of its operand. E.g. MVI B, 20 H
2. **Register addressing mode:** In this mode, the data is copied from one register to another i.e. the operands are specified as contents of a register. **E.g.** MOV A, B
3. **Direct addressing mode:** The address of the operand is specified in the instruction.
   E.g. LDA 3000 H
4. **Indirect addressing mode:** The data is transferred from the address pointed by the data in a register to another register. The address of the operand is in a register. **E.g.** MOV A, M
5. **Implied addressing mode:** The operand is implicit in the instruction and is not given explicitly.
   E.g. RAL, CMP etc.

Q.6 Explain different types of interrupts available in an 8085 microprocessor in details.

Solution:

An interrupts is a signal to the processor generated by hardware or software indicating an event that needs immediate action.

Types of Interrupts:

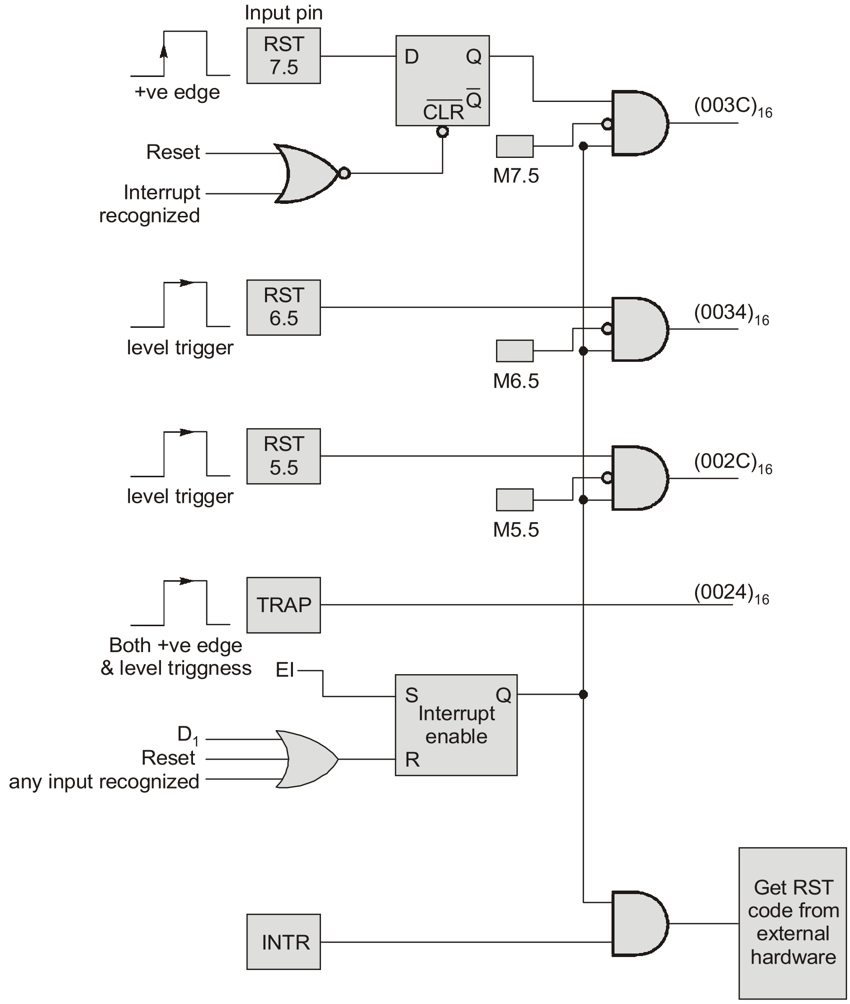
The 8085 has multilevel interrupt system. It supports two types of interrupts:

(a) Hardware (b) Software

Hardware: An external device initiates the hardware interrupts and placing an appropriate signal at the interrupt pin of the processor. If the interrupt is accepted then the processor executes an interrupt service routine.

Software: The cause of the interrupt is an execution of the instruction. These are special instructions supported by the microprocessor. After execution of these instructions microprocessor completes the execution of the instruction it is currently executing and transfers the program control to sub-routine.

There are five hardware interrupts:



TRAP:

- is a non-maskable interrupt.
- TRAP has the highest priority and vectored interrupt
- +ve edge and level triggered
- in case of sudden power failure, it executes a ISR and send the data from main memory to back up memory.

RST 7.5:

- is a maskable interrupt
- has the second highest priority
- is edge sensitive
- enabled by EI instruction

RST 6.5 & 5.5:

- both are level triggered i.e. input goes to high and stay high until it recognized
- maskable interrupt
- RST 6.5 has 3rd priority and RST 5.5 has 4th priority

INTR:

- is a maskable interrupt
- enabled by EI instruction
- it is a level sensitive interrupts

Software Interrupts in 8085:

The 8085 has eight software interrupts from RST0 to RST7. The vector address for these interrupts can be calculated as:

Interrupt number × 8 = vector address

Instruction	Vector add
RST 0	0000H
RST 1	0008H
RST 2	0010H
RST 3	0018H
RST 4	0020H
RST 5	0028H
RST 6	0030H
RST 7	0038H

Q.7 What are the functions of the following pins of 8085 microprocessor?

(i) READY (ii) ALE

(iii) HOLD (iv) TRAP

Solution:

(i) READY (Input): It is used by the microprocessor to sense or detect whether a peripheral is ready to transfer the data or not. A slow peripheral may be connected to the microprocessor through READY Line. If READY is HIGH the peripheral devices are ready, if it is LOW then the microprocessor waits till it goes HIGH.

(ii) ALE : (Address Latch Enable): This is a positive going pulse or signal that is generated every time the 8085 Microprocessor begins an operation. It goes HIGH during first clock cycle of a M/C and enables the lower 8-bits of the address to be Latched either into the memory or external Latch.

(iii) HOLD (Input): It indicates that another device is requesting for use of the address and data bus. After receiving a HOLD request, the microprocessor relinquishes the use of the buses as soon as the current machine cycle is completed. The processor regains the bus after the removal of the HOLD signal.

(iv) TRAP (Input): It is a non-maskable interrupt having the highest priority among all interrupts. It is unaffected by any mask or interrupt enable.

Q.8 Draw the Pin diagram of 8085 microprocessor and briefly explain it.

Solution:

The 8085 A (Commonly known as the 8085) is an 8 bit general purpose microprocessor, capable of addressing 64 K of memory. The device has forty (40) pins, requires a +5 V single power supply, and can operate with 3 MHz single phase clock.

- Figure below shows the pin diagram of 8085 microprocessor. All the pins can be classified into six groups:

  ⇒ Address bus

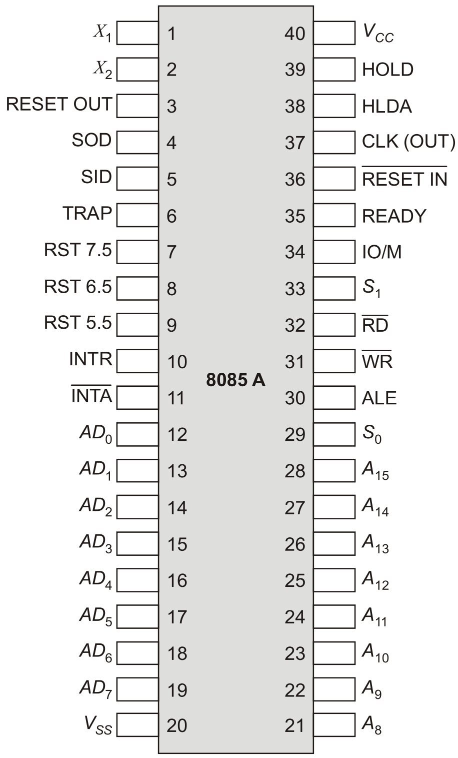
  ⇒ Data bus

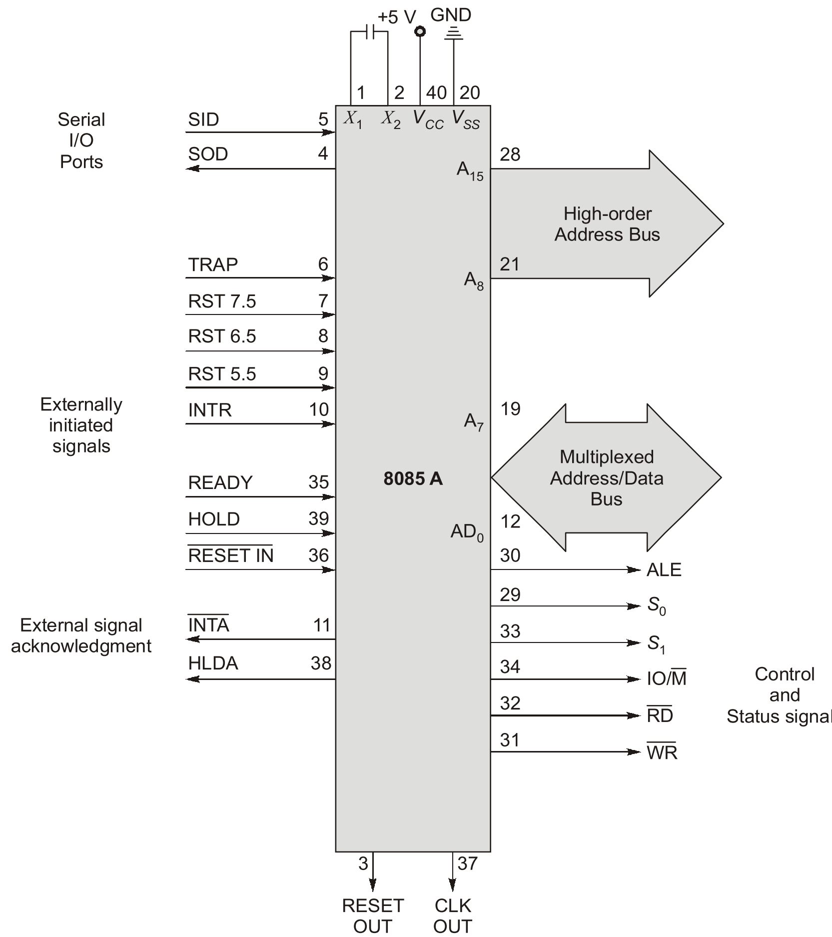
⇒ Control and Status signals

⇒ Power supply and Frequency signals

⇒ Externally initiated signals and

⇒ Serial Input/output ports.





Address Bus:

- It is 16 bits of length.
- It is unidirectional bus.
- It is divided into two parts namely,
  Lower order address bus ($A_0 - A_7$) – called line number. Lower address bus is also multiplexed with data links.
  Higher order address bus ($A_8 - A_{15}$) – called page number.

Data Bus:

- It is 8 bits of length.
- It is bidirectional bus.
- It is multiplexed with lower order address bus with lines ($AD_0 - AD_7$).

Controls and Status Signals:

- $\overline{RD}$ and $\overline{WR}$ are called control signals.
- $IO/\overline{M}$, S_1 and S_0 are called status signals.
- ALE (Address Latch Enable) is a special signal to indicate the beginning of the operation.

$\overline{\text{RD}}$: Read:

- This is real control (active low) signal.
- It indicates that the selected I/O or memory is to be read.

MATERIALS SCIENCE

CONVENTIONAL PRACTICE SETS

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1 CHAPTER Introduction to Engineering Materials

Q.1 Discuss the difference in covalent bonding in carbon as:
(i) diamond (ii) graphite

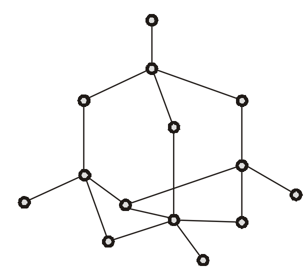
Solution:

(i) Covalent bonding of Carbon in diamond:

In diamond, every carbon atom bonds with four other adjoining atoms in a continuous network. No electrons are left unbonded. This results in very strong bonds between carbon atoms and is responsible for the great hardness of diamonds and their clear colourless appearance. Their great density bends light more than other crystals do making their appearance so spectacular.

Valance electrons of carbon atoms in diamonds are bonded to 4 electrons in ***Tetrahedral arrangement***. The covalent bond is very strong, this makes diamonds have high melting points, the covalent bond in three dimensional structure causes diamond to become the hardest material.

The bonding of electrons, diamonds have deme shaped structures. Deme is one of the strongest structures. Diamond forces more carbon atoms into a smaller denser package. Since there are no free electrons to wander through the structure, diamonds are excellent insulators. The brilliance and fire of cut diamonds is due to a very high index of refraction (2.42) and the strong dispersion of light, properties which are related to the structure of diamonds.



Diamond

(ii) Covalent bonding of Carbon in Graphite:

In graphite, each carbon atom shares electrons with only three neighbouring carbon atoms, leaving the fourth electron relatively free to roam around from one carbon atom to another, in much the same way as metals do. The carbon atoms form a network consisting of layers of interconnected carbons able to slide against each other making in a pencil. Unlike diamond, graphite is soft, pitch black in colour, and conducts electricity due to the free roaming valence electrons.

Valence electrons of graphite are only bonded to 3 valence electrons, so the covalent bond in hexagonal ring. Graphite is softer than diamond because they are held by weak intermolecular force. Graphite sheet like array of carbon atoms joined with minimal pressure.

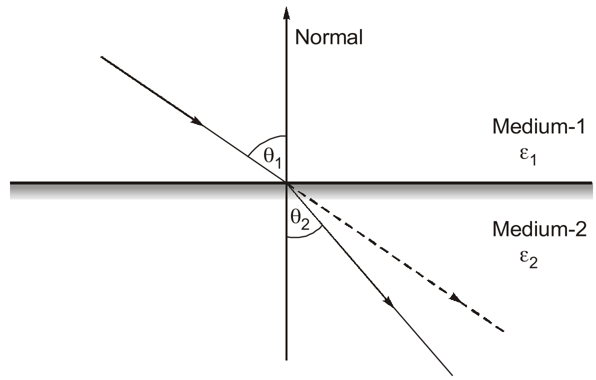
Q.2 (a) What is the value of directional bond angle in diamond and also write the coordination number of diamond cubic structure?

(b) An electric field in a medium having relative permittivity ‘7’ is passed into medium of relative permittivity of ‘2’. If $\vec{E}$ makes an angle of 60° with the boundary normal then what angle does the field make with normal in the second medium?

Solution:

(a) As we know that diamond structure has sp^3 hybrid covalent bond and each of its atom has four bonds. The directional bond angle in diamond structure is 109.5°. There are tetrahedral coordination of carbon atoms, hence the coordination number of diamond cubic structure is **Four (4).**

(b) According to the question we have,



Given that, $\varepsilon_1 = 7,\ \varepsilon_2 = 2,\ \theta_1 = 60°$ and $\theta_2 = ?$

From the law of refraction of $\vec{E}$ lines of forces across a boundary we get,

$$\frac{\tan\theta_1}{\tan\theta_2} = \frac{\varepsilon_1}{\varepsilon_2}$$

or $$\frac{\tan 60°}{\tan\theta_2} = \frac{7}{2} = 3.5$$

or $$\tan\theta_2 = \frac{1.732}{3.5}$$

or $$\theta_2 = \tan^{-1}(0.4948) = 26.32°$$

$\therefore$ $\vec{E}$ makes an angle 26.32° with normal in the second medium.

Q.3 Discuss about primary bonding and secondary bonding.

Solution:

Primary bonds are of three types:

(i) Ionic (ii) Covalent (iii) Metallic

(i) Ionic: It is developed between two atoms where one atom has low ionisation energy and the other has high electron affinity. The atoms exchange electrons to become oppositely charged ions and consequently develop a strong electrostatic force.

Therefore, ionic bond is an electrostatic force of attraction between two oppositely charged ions formed by the process of electron transfer between the related atoms.

Example:

$Li - 1s^2\,2s^1$ 1 excess electron

$Na - 1s^2\,2s^2\,2p^6\,3s^1$ 1 excess electron

(ii) Covalent bonds: When two similar atoms share equal electrons, the bond between them is known as a covalent bonds. As these electrons circulate between the atoms, they spend more time between the atoms than elsewhere which produces an electric force.

These bonds are strong and directional in nature.

These are of three types:

(a) Sigma bond (b) Pi-bond (c) Hybrid bond

(iii) Metallic bonds: In a metal, free electrons are present in a very large number and they behave like electron gas. The interaction between electron gas and the positive metal ions leads to a strong cohesive force and give rise to metallic bond. The presence of such free electrons in a metal account nicely. For the high electrical and thermal conductivities, heat capacity surface lustre and other unique properties. Also these electrons never move inside a metal or in any solid with total freedom. All of them are influenced, to some extent by the other particles present inside and when their presence is taken into consideration.

Secondary Bonds: As compared to primary bonds, secondary bonds are weak. The driving force arises due to the attraction of electric dipoles contained in atoms or molecules.

(i) **Van der Waals Bonds:**

Atoms, molecules or ions of all substances exert attractive force on each other when they are brought closer bond so developed is known as Van der Waals bond. The forces that act are proportional to r^{-7} where r is separation between the atoms or molecules.

(ii) **Hydrogen Bond:**

Certain compounds, notably water, have much higher boiling and melting points than would be expected.

Example : Non-metallic hydrides H_2Te, H_2Se and H_2S.

Have the respective boiling points of –2°, –42° and –60° while H_2O with a still smaller molecular weight has a boiling point of 100°C.

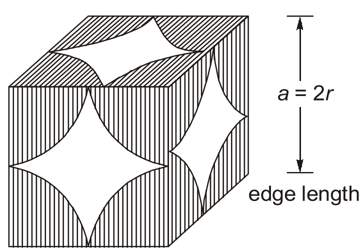
Q.4 **What are the main types of cubic crystal structure? Define atomic packing factor of all the cubic crystal structure materials.**

Solution:

There are three types of cubic crystal structures:

- **Simple Cubic Crystal structure (SCC):**

  In this structure, there is one Lattice point at each of the eight corners of the unit cell. It has a coordination number of six.



Atomic Packing Factor (APF) of the crystal structure is defined as the ratio of total volume of the atoms per unit cell to the volume of the unit cell. It is also known as packing efficiency (η).

Here, $$\text{APF} = \frac{1\times(\pi/6)a^3}{a^3} = \frac{\pi}{6} = 0.524$$

∴ % APF = 52.4% filled

- **Body Centred Cubic structure (BCC):**

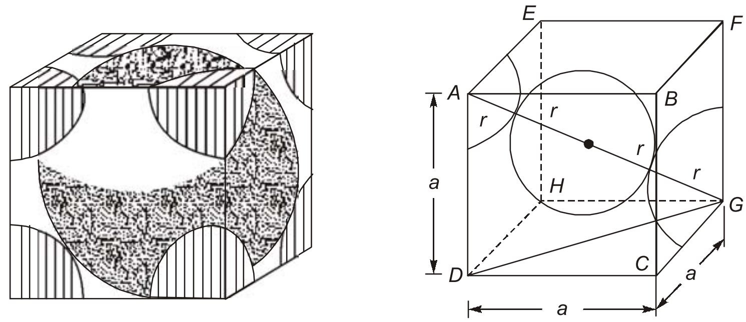
  In this structure, in a unit cell there are eight corners and another atom is at the body centred. It has a co-ordination number of eight.

Note: (i) Simple cubic crystal

APF = 0.524 = 52.4%

(ii) BCC, APF = 0.68 = 68%

(iii) FCC, APF = 0.74 = 74%



(a) (b)

Body centered cubic structure

From the figure, $r = \dfrac{a\sqrt{3}}{4}$

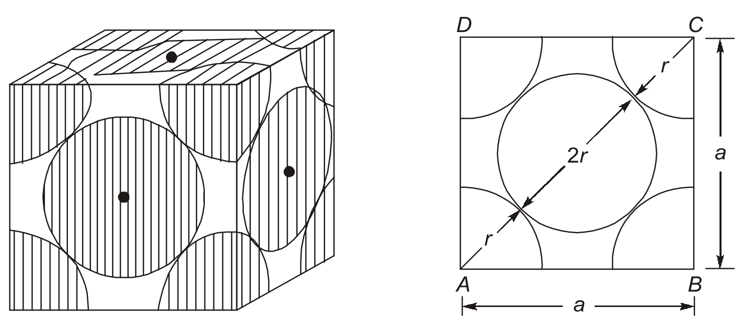
Number of atom per unit cell and for BCC, $N = 2$

Now, $(\text{APF})_{BCC} = \dfrac{\text{N} \times \text{Volume of each sphere}}{\text{Total volume of each cell}}$

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

$\therefore$ % APF = 68% filled

- **Face Centred Cubic structure (FCC):** In this structure, one atom lies at each corner of the cube in addition to one atom at the centre of each face. The co-ordination number of FCC structure is (4 + 4 + 4 = 12).



(a) (b)

(Face centered cubic structure)

From the figure, Radius of FCC $= r = \dfrac{a\sqrt{2}}{4}$

Number of atom per unit cell and for FCC, $N = 4$

Now, $(\text{APF})_{FCC} = \dfrac{N \times \text{Volume of each sphere}}{\text{Total volume of each cell}}$

$$= \frac{4 \times \frac{4}{3}\pi \times \left(\frac{a\sqrt{2}}{4}\right)^3}{a^3} = \frac{\frac{4}{3} \times \frac{\sqrt{2}\pi a^3}{2^3}}{a^3} = \frac{\sqrt{2}\pi}{6} = \frac{\pi}{3\sqrt{2}} = 0.74$$

$\therefore$ % APF = 74 % filled

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ELECTRONIC MEASUREMENTS & INSTRUMENTATION

CONVENTIONAL PRACTICE SETS

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1
CHAPTER

Errors in Measurements

Q.1 Four ammeters M1, M2, M3 and M4 with the following specifications are available:

Instrument	Type	Full scale value (A)	Accuracy % of FS
M1	$3\frac{1}{2}$ digit dual slope	20	±0.10
M2	PMMC	10	±0.20
M3	Electro-dynamic	5	±0.50
M4	Moving-iron	1	±1.00

A current of 1 A is to be measured. Calculate the error in the reading of each instruments and which meter has least error?

Solution:

Error in reading of first meter = FSD × accuracy = $20 \times \frac{\pm 0.1}{100} = \pm 0.02$

Error in reading of second meter = $10 \times \frac{\pm 0.2}{100} = \pm 0.02$

Error in reading of third meter = $5 \times \frac{\pm 0.5}{100} = \pm 0.025$

Error in reading of fourth meter = $1 \times \frac{\pm 1.00}{100} = \pm 0.01$

Fourth meter has least error.

Q.2 The dead zone of a certain pyrometer is 0.125 percent of the span. The calibration is 800°C to 1800°C. What temperature change must occur before it is detected?

Solution:

Given that, Span $= 1800° - 800° = 1000°C$

$$\text{Dead zone} = \frac{0.125}{100} \times 1000° = 1.25°C$$

A change of 1.25°C must occur before it is detected.

Q.3 The limiting errors for a four dial resistance box are:

Units : ±0.2%

Tens : ±0.1%

Hundreds : ±0.05%

Thousands : ±0.02%

If the resistance value is set at 4325 Ω calculate the limiting error for this value.

Solution:

Thousand is set at 4000 Ω and error

$$= \pm 4000 \times \frac{0.02}{100} = \pm 0.8\ \Omega$$

$$\text{For hundred error} = \pm 300 \times \frac{0.05}{100} = \pm 0.15\ \Omega$$

Similarly, $$\text{For ten error} = \pm 20 \times \frac{0.1}{100} = \pm 0.02\ \Omega$$

and $$\text{For unit error} = \pm 5 \times \frac{0.2}{100} = \pm 0.01\ \Omega$$

Hence, $$\text{Total error} = \pm(0.8 + 0.15 + 0.02 + 0.01)\ \Omega = \pm 0.98\ \Omega$$

$$\%\ \text{Relative error} = \frac{0.98}{4325} \times 100 = 0.0226\%$$

Q.4 The following measurement are obtained on a single-phase load:

V = 200 V ± 1%, I = 5 A ± 1% and P = 555 W ± 2%

If the power factor is calculated using these measurements. What is the calculated power factor in the worst case error?

Solution:

Given that, Voltage, $V = 220 \pm 1\%$,

Current, $I = 5 \pm 1\%$

Power, $P = 555 \pm 2\%$

$$P = VI \cdot \cos(\phi)$$

⇒ Power factor, $$\text{p.f} = \cos(\phi) = \frac{P}{V.I}$$

$$\text{p.f.} = \cos(\phi) = \frac{555 \pm 2\%}{(220 \pm 1\%)(5 \pm 1\%)} = \frac{555}{220 \times 5} \pm 4\%$$

$$\text{p.f.} = \cos(\phi) = 0.5 \pm 4\%$$

Q.5 An 820 Ω resistance with an accuracy of ±10% carries a current of 10 mA. The current was measured by an analog meter of 25 mA range with an accuracy of ±2% of full scale. Compute the power dissipated in the resistor and determine the accuracy of the result.

Solution:

Resistance, $R = (820 \pm 10\%)\ \Omega$

Current, $I = 10$ mA

Full scale current = 25 mA

Accuracy in current = ±2% of FSD

= ±2% × 25 mA = 0.5 mA

∴ $I = 10\text{ mA} \pm 0.5\text{ mA}$

or $I = (10\text{ mA} \pm 5\%)\text{ mA}$

Power, $P = I^2R$

$$P = (10\text{ mA})^2 \cdot (820) = 0.082\text{ W}$$

Taking log on both sides, $\log P = \log(I^2R)$

Differentiating both sides, $$\frac{\partial P}{P} = 2\frac{\partial I}{I} + \frac{\partial R}{R}$$

$$\therefore \quad \frac{\partial P}{P} = 2 \times 5\% + 10\%$$

$$\frac{\partial P}{P} = 10\% + 10\%$$

$$\frac{\partial P}{P} = 20\%$$

$$\therefore \quad P = 0.082 \text{ W} \pm 20\%$$

Q.6 A variable w is related to three other variables x, y, z as $w = xy/z$. The variables are measured with meters of accuracy ± 0.5% reading, ± 1% of full scale value and ±1.5% reading. The actual readings of the three meters are 80, 20 and 50 with 100 being the full scale value for all three. Find the maximum limiting error in the measurement of variable w.

Solution:

Full scale reading of all three = 100

Readings of x = 80

Readings of y = 20

Reading of z = 50

$$\delta x = \pm 0.5\% \text{ of reading} = \pm\frac{0.5 \times 80}{100} = \pm 0.4$$

$$\delta y = \pm 1\% \text{ of full reading} = \pm\frac{1 \times 100}{100} = \pm 1$$

$$\delta z = \pm 1.5\% \text{ of reading} = \pm\frac{1.5 \times 50}{100} = \pm 0.75$$

Given,
$$w = \frac{xy}{z}$$

Taking log, we get

$$\log w = \log x + \log y - \log z$$

Differentiating w.r.t. w we get

$$\frac{\delta w}{w} = \frac{\delta x}{x} + \frac{\delta y}{y} - \frac{\delta z}{z}$$

For maximum limiting error,

$$\frac{\delta w}{w} = \pm\left(\frac{0.4}{80} + \frac{1}{20} + \frac{0.75}{50}\right) \times 100 = \pm 7.00\%$$

Q.7 The following readings were observed when measuring a voltage:

S.No.	1	2	3	4	5	6	7	8
Volts	532	548	543	535	546	531	543	536

Calculate:

(i) Average deviation

(ii) Standard deviation

(iii) Probable error of one reading.

Solution:

Given that:

S.No.	1	2	3	4	5	6	7	8
Volts	532	548	543	535	546	531	543	536

$$\text{Mean} = \frac{532+548+543+535+546+531+543+536}{8} = \frac{2157}{4} = 539.25$$

Deviations,

$$d_1 = 532 - 539.25 = -7.25$$
$$d_2 = 548 - 539.25 = 8.75$$
$$d_3 = 543 - 539.25 = 3.75$$
$$d_4 = 535 - 539.25 = -4.25$$
$$d_5 = 546 - 539.25 = 6.75$$
$$d_6 = 531 - 539.25 = -8.25$$
$$d_7 = 543 - 539.25 = 3.75$$
$$d_8 = 536 - 539.25 = -3.25$$

(i) Average deviation, $\bar{d}_{avg.} = \dfrac{|d_1|+|d_2|+|d_3|+|d_4|+|d_5|+|d_6|+|d_7|+|d_8|}{8} = 5.75$

(ii) Standard deviation, $\sigma = \sqrt{\dfrac{(d_1)^2+(d_2)^2+(d_3)^2+(d_4)^2+(d_5)^2+(d_6)^2+(d_7)^2+(d_8)^2}{n-1}}$

$$= \sqrt{\frac{299.5}{7}} = \sqrt{42.7857} = 6.541$$

(iii) Probable error $= 0.6745\,\sigma = 0.6745 \times 6.541 = 4.4119$

Q.8 **Two resistors R_1 and R_2 are connected in series and then in parallel. The values of resistance are:**

$$R_1 = 100.0 \pm 0.1\ \Omega\ ; \quad R_2 = 50 \pm 0.03\ \Omega$$

Calculate the uncertainty in the combined resistance for both series and parallel arrangements.

Solution:

When the two resistances are connected in series the resultant resistance is

$$R = R_1 + R_2$$

$$\frac{\partial R}{\partial R_1} = 1 \quad \text{and} \quad \frac{\partial R}{\partial R_2} = 1$$

Hence uncertainty in the total resistance is

$$\boxed{W_R = \pm\sqrt{\left(\frac{\partial R}{\partial R_1}\right)^2 W_{R_1}^2 + \left(\frac{\partial R}{\partial R_2}\right)^2 W_{R_2}^2}}$$

$$W_R = \pm\sqrt{(1)^2 \times (0.1)^2 + (1)^2 \times (0.03)^2} = \pm 0.1044\ \Omega$$

The total resistance is $R = 100 + 50 = 150\ \Omega$

and can be expressed as $R = 150 \pm 0.1044\ \Omega$

When the two resistances are connected in parallel the resultant resistance is

$$R = \frac{R_1 R_2}{(R_1 + R_2)} = \frac{100 \times 50}{100 + 50} = 33.3333\ \Omega$$

$$R = \frac{R_1 R_2}{(R_1 + R_2)}$$

$$\frac{\partial R}{\partial R_1} = \frac{R_2(R_1+R_2) - R_1 R_2 (1)}{(R_1+R_2)^2} = \frac{R_2}{R_1+R_2} - \frac{R_1 R_2}{(R_1+R_2)^2} = \frac{50}{150} - \frac{100 \times 50}{(150)^2} = 0.1111$$