SEMESTER – II/IV/VI

19MMU504/19CHU503 **PHYSICS – II** **4H - 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives:

- To give the basic knowledge on material properties.
- To acquire knowledge on magnetism and digital electronics.
- To educate and motivate the students in the field of science.

Course Outcomes:

Students can able to

- Explain how physics applies to phenomena in the world around them.
- Recognize how and when physics methods and principles can help address problems in their major and then apply those methods and principles to solve problems.

UNIT – I

Electrostatics: Coulombs law – electric field – Gauss's law and its applications – potential – potential due to various charge distribution. Parallel plate capacitors – dielectrics- current – galvanometer – voltmeter – ammeter- potentiometric measurements.

UNIT - II

Magnetism: Magnetic field – Biot Savart's law – B due to a solenoid – Amperes law – Faradays law of induction – Lenz's law. Magnetic properties of matter –Dia, para and ferro - Cycle of magnetization – Hysteresis – B-H curve – Applications of B-H curve.

UNIT - III

Modern Physics: Einstein's Photoelectric effect-characteristics of photoelectron –laws of photoelectric emission-Einstein's photo electric equations- Compton effect-matter waves-De-Broglie Hypothesis. Heisenberg's uncertainty principle-Schrödinger's equation- particle in a box.

UNIT-IV

Atomic and Nuclear Physics: Atom Models : Sommerfield's and Vector atom Models – Pauli's exclusion Principle – Various quantum numbers and quantization of orbits. X-rays : Continuous and Characteristic X-rays – Mosley's Law and importance – Bragg's Law.

Nuclear forces –characteristics - nuclear structure by liquid drop model – Binding energy – mass defect – particle accelerators – cyclotron and betatron – nuclear Fission and nuclear Fusion.

UNIT - V

Digital Electronics: Decimal – binary – octal and hexadecimal numbers– their representation, inter-conversion, addition and subtraction, negative numbers. Sum of products – product of sums – their conversion – Simplification of Boolean expressions - K-Map – min terms – max terms - (2, 3 and 4 variables). Basic logic gates – AND, OR, NOT, NAND, NOR and EXOR gates – NAND and NOR as universal building gates – Boolean Algebra – Laws of Boolean Algebra – De Morgan's Theorems – Their verifications using truth tables.

SUGGESTED READINGS

1. Narayanamurthi, Electricity and Magnetism, The National Publishing Co, First edition,1988.

2. J. B. Rajam, Atomic Physics., S. Chand & Company Limited, New Delhi, First edition, 1990.

3. B. N. Srivastava, Basic Nuclear Physic, Pragati Prakashan, Meerut, 2005.

4. Albert Paul Malvino, Digital principles and Applications, McGraw-Hill International Editions, New York, 2002.

5. Digital fundamentals – by Floyd 8th edition Pearson education 2006

6. R. S. Sedha, A text book of Digital Electronics, S. Chand & Co, New Delhi, First edition ,2004.

UNIT – I

Electrostatics: Coulombs law – electric field – Gauss's law and its applications – potential – potential due to various charge distribution. Parallel plate capacitors – dielectrics- current – galvanometer – voltmeter – ammeter- potentiometric measurements.

Electrostatics:

Coulomb's law

The force between two charged bodies was studied by Coulomb in 1785.Coulomb's law states that the force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them. The direction of forces is alongthe line joining the two point charges.

One Coulomb is defined as the quantity of charge, which when placed at a distance of 1 metre in air or vacuum from an equal and similar charge, experiences a repulsive force of 9×10^9 N. The forces exerted by charges on each other are equal in magnitude and opposite in direction.

Electric Field

Electric field due to a charge is the space around the test charge in which it experiences a force. The presence of an electric field around a charge cannot be detected unless another charge is brought towards it.

When a test charge $q_o$is placed near a charge q, which is the source of electric field, an electrostatic force F will act on the test charge.

Gauss's law

The law relates the flux through any closed surface and the netcharge enclosed within the surface. The law states that the total flux

1

of the electric field E over any closed surface is equal to $\frac{}{\varepsilon_o}$ times the net charge enclosed by the surface.

q —

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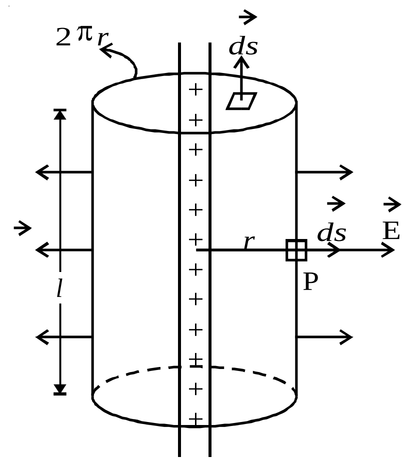
$\varphi = \varepsilon o$

This closed imaginary surface is called Gaussian surface. Gauss's law tells us that the flux of E through a closed surface S depends only on the value of net charge inside the surface and not on the location of the charges. Charges outside the surface will not contribute to flux.

Applications of Gauss's Law

i) **Field due to an infinite long straight charged wire**

Consider an uniformly charged wire of infinite length having a constant linear charge density λ (charge per unit E length). Let P be a point at a distance r from the wire (Fig. 1.17) and E be the electric field at the point P. A cylinder of length *l*, radius r, closed at each end by plane caps normal to the axis is chosen as Gaussian surface. Consider a very *Fig 1.17 Infinitely long* small area *ds* on the Gaussian surface. *straight charged wire* By symmetry, the magnitude of the electric field will be the same at all points on the curved surface of the cylinder and directed radially outward. E and *ds* are along the same direction.



The electric flux (φ) through curved surface = $\int E\, ds \cos\theta$

$\varphi = \int E\, ds$ [∵θ= 0;cosθ=1]

$= E (2\pi r l)$

(∵ The surface area of the curved part is 2π rl)

Since E and *ds* are right angles to each other, the electric flux through the plane caps = 0

∴ Total flux through the Gaussian surface, φ = E. (2πrl)

The net charge enclosed by Gaussian surface is, q = λl

∴ By Gauss's law,

$E (2\pi r l) = \frac{\lambda l}{\varepsilon_o}$ or $E = \frac{\lambda}{2\pi\varepsilon_o r}$

The direction of electric field E is radially outward, if line charge is positive and inward, if the line charge is negative.

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Electric field due to an infinite charged plane sheet

Consider an infinite plane sheet of charge with surface charge density σ. Let P be a point at a distance *r* from the sheet (Fig. 1.18) and E be the electric field at P. Consider a Gaussian surface in the form of cylinder of cross− sectional area A and length *2r* perpendicular to the sheet of charge. *Fig 1.18 Infinite plane sheet* By symmetry, the electric field is at right angles to the end caps and away from the plane. Its magnitude is the same at P and at the other cap at P′.
Therefore, the total flux through the closed surface is given by

$$\varphi = \int E\, ds \Big|_P + \int E\, ds \Big|_{P1} \quad (\because \theta = 0, \cos\theta = 1)$$

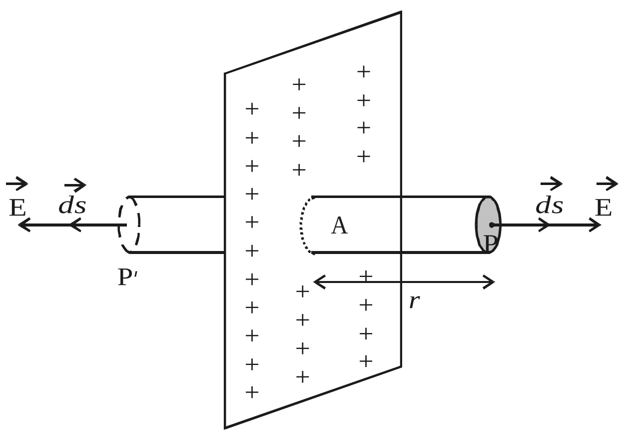
$$= E A + E A = 2 E A$$

If σ is the charge per unit area in the plane sheet, then the net positive charge *q* within the Gaussian surface is, $q = \sigma A$

Using Gauss's law,

$$2 E A = \frac{\sigma A}{\varepsilon_o}$$

$$\therefore E = \frac{\sigma}{2\varepsilon_o}$$



Capacitance of a conductor

When a charge *q* is given to an isolated conductor, its potential will change. The change in potential depends on the size and shape of the conductor. The potential of a conductor changes by V, due to the charge *q* given to the conductor.

$q \propto V$ or $q = CV$

i.e. $C = q/V$

Here C is called as capacitance of the conductor.

The capacitance of a conductor is defined as the ratio of the charge given to the conductor to the potential developed in the conductor.

The unit of capacitance is farad. A conductor has a capacitance of one farad, if a charge of 1 coulomb given to it, rises its potential by 1 volt.

The practical units of capacitance are μF and pF.

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Principle of a capacitor

Consider an insulated conductor (Plate A) with a positive charge '*q*' having potential V (Fig 1.22a). The capacitance of A is C = q/V. When another insulated metal plate B is brought near A, negative charges are induced on the side of B near A. An equal amount of positive charge is induced on the other side of B (Fig 1.22b). The negative charge in B decreases the potential of A. The positive charge in B increases the potential of A. But the negative charge on B is nearer to A than the positive charge on B. So the net effect is that, the potential of A decreases. Thus the capacitance of A is increased.

If the plate B is earthed, positive charges get neutralized (Fig 1.22c). Then the potential of A decreases further. Thus the capacitance of A is considerably increased. The capacitance depends on the geometry of the conductors and nature of the medium. A capacitor is a device for storing electriccharges.

A A B A

B

++ -++ -
++ -++ -
++ -++ -
++ -++ -
++ -++ -
++ -++ -
++ -++ -
++ -++ -
++ -++ -

Fig 1.22 Principle of capacitor

Capacitance of a parallel plate capacitor

The parallel plate capacitor consists of two parallel metal plates X and Y each of area A, separated by a distance *d*, having a surface charge

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density σ (fig. 1.23). The medium

-q

+*q* is given to the plate X. It induces

a charge –*q* on the upper surface of *Fig 1.23 Parallel plate capacitor* earthed plate Y. When the plates are very close to each other, the field is confined to the region between them. The electric lines of force starting from plate X and ending at the plate Y are parallel to each other and perpendicular to the plates.

By the application of Gauss's law, electric field at a point between the two plates is,

$$E = \frac{\sigma}{\varepsilon_o}$$

Potential difference between the plates X and Y is

$$V = \int_d^0 -E\, dr = -\int_d^0 \frac{\sigma}{\varepsilon_o} dr = \frac{\sigma d}{\varepsilon_o}$$

The capacitance (C) of the parallel plate capacitor

$$C = \frac{q}{V} = \frac{\sigma A}{\sigma d/\varepsilon_o} \quad \left[\text{since}, \sigma = \frac{q}{A}\right]$$

$$\therefore \quad C = \frac{\varepsilon_o A}{d}$$

The capacitance is directly proportional to the area (A) of the plates and inversely proportional to their distance of separation (d).

Dielectrics and polarization

Dielectrics

A dielectric is an insulating material in which all the electrons are tightly bound to the nucleus of the atom. There are no free electrons to carry current. Ebonite, mica and oil are few examples of dielectrics. The electrons are not free to move under the influence of an external field.

UNIT – III

Modern Physics: Einstein's Photoelectric effect-characteristics of photoelectron –laws of photoelectric emission-Einstein's photo electric equations- Compton effect-matter waves-De-Broglie Hypothesis. Heisenberg's uncertainty principle-Schrödinger's equation- particle in a box.

Modern Physics

Einstein's Photoelectric effect

The photoelectric effect is a phenomenon where electrons are emitted from the metal surface when the light of sufficient frequency is incident upon. The concept of photoelectric effect was first documented in 1887 by Heinrich Hertz and later by Lenard in 1902. But both the observations of the photoelectric effect could not be explained by Maxwell's electromagnetic wave theory of light. Hertz (who had proved the wave theory) himself did not pursue the matter as he felt sure that it could be explained by the wave theory. It, however, failed on the following accounts:

According to the wave theory, energy is uniformly distributed across the wavefront and is dependent only on the intensity of the beam. This implies that the kinetic energy of electrons increases with light intensity. However, the kinetic energy was independent of light intensity.
Wave theory says that light of any frequency should be capable of ejecting electrons. But electron emission occurred only for frequencies larger than a threshold frequency (ν0).
Since energy is dependent on intensity according to wave theory, the low-intensity light should emit electrons after some time so that the electrons can acquire sufficient energy to get emitted. However, electron emission was spontaneous no matter how small the intensity of light.
Following is the table with link of other experiment related to photoelectric effect:

Einstein's explanation of Photoelectric effect

Einstein resolved this problem using Planck's revolutionary idea that light was a particle. The energy carried by each particle of light (called quanta or photon) is dependent on the light's frequency (ν) as shown:
E = hν
Where *h = Planck's constant = 6.6261 × 10-34 Js.*
Since light is bundled up into photons, Einstein theorized that when a photon falls on the surface of a metal, the entire photon's energy is transferred to the electron.

A part of this energy is used to remove the electron from the metal atom's grasp and the rest is given to the ejected electron as kinetic energy. Electrons emitted from underneath the metal surface lose some of the kinetic energy during the collision. But the surface electrons carry all the kinetic energy imparted by the photon and have the maximum kinetic energy.
We can write this mathematically as:

Energy of photon
= energy required to eject electron (work function) + Maximum kinetic energy of the electron
E = W + KE
hv = W + KE
KE = hv – w

At the threshold frequency v0 electrons are just ejected and do not have any kinetic energy. Below this frequency there is no electron emission. Thus, the energy of a photon with this frequency must be the work function of the metal.

w = hv_0
Thus, Maximum kinetic energy equation becomes:
KE = 12mv2max=hv–hv_0
12mv2max=h(v−v_0)

Vmax is the maximum kinetic energy of the electron. It is calculated experimentally using the stopping potential. Please read our article on Lenard's observations to understand this part.

Stopping potential = ev_0 = 12mv2max
Thus, Einstein explained the Photoelectric effect by using the particle nature of light.
Stay tuned with BYJU'S to learn more about the photoelectric effect along with engaging video lectures.

Compton effect, increase in wavelength of X-rays and other energetic electromagnetic radiations that have been elastically scattered by electrons; it is a principal way in which radiant energy is absorbed in matter. The effect has proved to be one of the cornerstones of quantum mechanics, which accounts for both wave and particle properties of radiation as well as of matter.

Matter waves

It is **the wave** formed by **matter**, or in another word, particles. Precisely speaking, every **matter** formed by particles, or just particles like electrons, have **wave**-like **property**, which means they can behave both like particles and **waves**. It is only when particles move that they have **wave**-like **property**

De Broglie's Thesis

In his 1923 (or 1924, depending on the source) doctoral dissertation, the French physicist Louis de Broglie made a bold assertion. Considering Einstein's relationship of wavelength *lambda* to momentum *p*, de Broglie proposed that this relationship would determine the wavelength of any matter, in the relationship:

lambda = *h* / *p*

recall that *h* is Planck's constant

This wavelength is called the *de Broglie wavelength*. The reason he chose the momentum equation over the energy equation is that it was unclear, with matter, whether *E* should be total energy, kinetic energy, or total relativistic energy. For photons, they are all the same, but not so for matter.

Assuming the momentum relationship, however, allowed the derivation of a similar de Broglie relationship for frequency *f* using the kinetic energy E_k:

$f = E_k / h$

Alternate Formulations

De Broglie's relationships are sometimes expressed in terms of Dirac's constant, *h-bar* = *h* / (2*pi*), and the angular frequency *w* and wavenumber *k*:

p = *h-bar* * kE_k

= *h-bar* * *w*

Experimental Confirmation

In 1927, physicists Clinton Davisson and Lester Germer, of Bell Labs, performed an experiment where they fired electrons at a crystalline nickel target. The resulting diffraction pattern matched the predictions of the de Broglie wavelength. De Broglie received the 1929 Nobel Prize for his theory (the first time it was ever awarded for a Ph.D. thesis) and Davisson/Germer jointly won it in 1937 for the experimental discovery of electron diffraction (and thus the proving of de Broglie's hypothesis).

Further experiments have held de Broglie's hypothesis to be true, including the quantum variants of the double slit experiment. Diffraction experiments in 1999 confirmed the de Broglie wavelength for the behavior of molecules as large as buckyballs, which are complex molecules made up of 60 or more carbon atoms.

Significance of the de Broglie Hypothesis

The de Broglie hypothesis showed that wave-particle duality was not merely an aberrant behavior of light, but rather was a fundamental principle exhibited by both radiation and matter. As such, it becomes possible to use wave equations to describe material behavior, so long as one properly applies the de Broglie wavelength. This would prove crucial to the development of quantum mechanics. It is now an integral part of the theory of atomic structure and particle physics.

Macroscopic Objects and Wavelength

Though de Broglie's hypothesis predicts wavelengths for matter of any size, there are realistic limits on when it's useful. A baseball thrown at a pitcher has a de Broglie wavelength that is smaller than the diameter of a proton by about 20 orders of magnitude.

The Heisenberg uncertainty principle states that it is impossible to know simultaneously the exact position and momentum of a particle. That is, the more exactly the position is determined, the less known the momentum, and vice versa. This principle is not a statement about the limits of technology, but a fundamental limit on what can be known about a particle at any given moment. This uncertainty arises because the act of measuring affects the object being measured. The only way to measure the position of something is using light, but, on the sub-atomic scale, the interaction of the light with the object inevitably changes the object's position and its direction of travel.

The Schrödinger Equation and a Particle in a Box

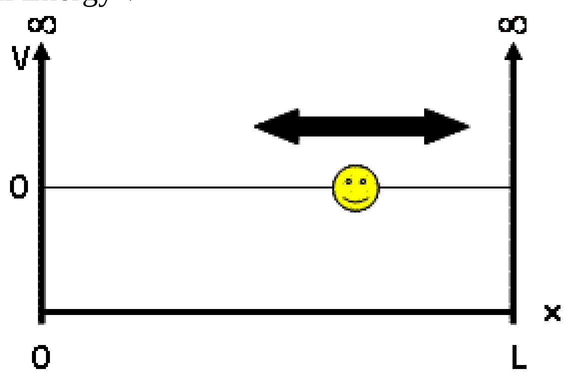
The particle in a box model (also known as the infinite potential well or the infinite square well) describes a particle free to move in a small space surrounded by impenetrable barriers. The model is mainly used as a hypothetical example to illustrate the differences between classical and quantum systems. In classical systems, for example a ball trapped inside a large box, the particle can move at any speed within the box and it is no more likely to be found at one position than another. However, when the well becomes very narrow (on the scale of a few nanometers), quantum effects become important. The particle may only occupy certain positive energy levels. The particle in a box model provides one of the very few problems in quantum mechanics which can be solved analytically, without approximations. This means that the observable properties of the particle (such as its energy and position) are related to the mass of the particle and the width of the well by simple mathematical expressions. Due to its simplicity, the model allows insight into quantum effects without the need for complicated mathematics. It is one of the first quantum mechanics problems taught in undergraduate physics courses, and it is commonly used as an approximation for more complicated quantum systems.

A particle in a 1-dimensional box is a fundamental quantum mechanical approximation describing the translational motion of a single particle confined inside an infinitely deep well from which it *cannot* escape.

The particle in a box problem is a common application of a quantum mechanical model to a simplified system consisting of a particle moving horizontally within an infinitely deep well from which it cannot escape. The solutions to the problem give possible values of E and $\psi\psi$ that the particle can possess. E represents allowed energy values and ψ(x)ψ(x) is a wavefunction, which when squared gives us the probability of locating the particle at a certain position within the box at a given energy level.

To solve the problem for a particle in a 1-dimensional box, we must follow our **Big, Big recipe for Quantum Mechanics:**

Define the Potential Energy, *V*
Solve the Schrödinger Equation
Define the wavefunction
Define the allowed energies
Step 1: Define the Potential Energy *V*



***A particle in a 1D infinite potential well of dimension* LL.**

The potential energy is *0 inside the box* (V=0 for 0<x<L) and *goes to infinity at the walls of the box* (V=∞ for x<0 or x>L). We assume the walls have infinite potential energy to ensure that the particle has zero probability of being at the walls or outside the box. Doing so significantly simplifies our later mathematical calculations as we employ these **boundary conditions** when solving the Schrödinger Equation.

Step 2: Solve the Schrödinger Equation
The time-independent Schrödinger equation for a particle of mass *m* moving in one direction with energy *E* is

−ℏ22md2ψ(x)dx2+V(x)ψ(x)=Eψ(x)(1)(1)−ℏ22md2ψ(x)dx2+V(x)ψ(x)=Eψ(x)

with
ℏℏ is the reduced Planck Constant where ℏ=h2πℏ=h2π
m is the mass of the particle
ψ(x)ψ(x) is the stationary time-independent wavefunction
V(x) is the potential energy as a function of position
EE is the energy, a real number

This equation can be modified for a particle of mass *m* free to move parallel to the x-axis with zero potential energy (V = 0 everywhere) resulting in the quantum mechanical description of free motion in one dimension:

−ℏ22md2ψ(x)dx2=Eψ(x)(2)(2)−ℏ22md2ψ(x)dx2=Eψ(x)

This equation has been well studied and gives a general solution of:

ψ(x)=Asin(kx)+Bcos(kx)(3)(3)ψ(x)=Asin(kx)+Bcos(kx)

where A, B, and k are constants.

Step 3: Define the wavefunction

The solution to the Schrödinger equation we found above is the general solution for a 1-dimensional system. We now need to apply our **boundary conditions** to find the solution to our particular system. According to our boundary conditions, the probability of finding the particle at x=0 or x=L is zero. When x=0x=0, sin(0)=0sin(0)=0, and cos(0)=1cos(0)=1; therefore, *B must equal 0* to fulfill this boundary condition giving:
ψ(x)=Asin(kx)(4)(4)ψ(x)=Asin(kx)

We can now solve for our constants (A and k) systematically to define the wavefunction.

Solving for k

Differentiate the wavefunction with respect to x:

dψdx=kAcos(kx)(5)(5)dψdx=kAcos(kx)
d2ψdx2=−k2Asin(kx)(6)(6)d2ψdx2=−k2Asin(kx)
Since ψ(x)=Asin(kx)ψ(x)=Asin(kx), then

d2ψdx2=−k2ψ(7)(7)d2ψdx2=−k2ψ

If we then solve for k by comparing with the Schrödinger equation above, we find:

k=(8π2mEh2)1/2(8)(8)k=(8π2mEh2)1/2

Now we plug k into our wavefunction:

ψ=Asin(8π2mEh2)1/2x(9)(9)ψ=Asin(8π2mEh2)1/2x

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Solving for A

To determine A, we have to apply the boundary conditions again. Recall that the *probability of finding a particle at x = 0 or x = L is zero.*

When x=Lx=L:

0=Asin(8π2mEh2)1/2L(10)(10)0=Asin(8π2mEh2)1/2L
This is only true when
(8π2mEh2)1/2L=nπ(11)(11)(8π2mEh2)1/2L=nπ
where n = 1,2,3…

Plugging this back in gives us:

ψ=AsinnπLx(12)(12)ψ=AsinnπLx
To determine AA, recall that the total probability of finding the particle inside the box is 1, meaning there is no probability of it being outside the box. When we find the probability and set it equal to 1, we are *normalizing* the wavefunction.
∫L0ψ2dx=1(13)(13)∫0Lψ2dx=1

For our system, the normalization looks like:

A2∫L0sin2(nπxL)dx=1(14)(14)A2∫0Lsin2(nπxL)dx=1
Using the solution for this integral from an integral table, we find our normalization constant, AA:
A=2L−−√(15)(15)A=2L

Which results in the normalized wavefunction for a particle in a 1-dimensional box:

ψ=2L−−√sinnπLx(16)(16)ψ=2LsinnπLx
Step 4: Determine the Allowed Energies

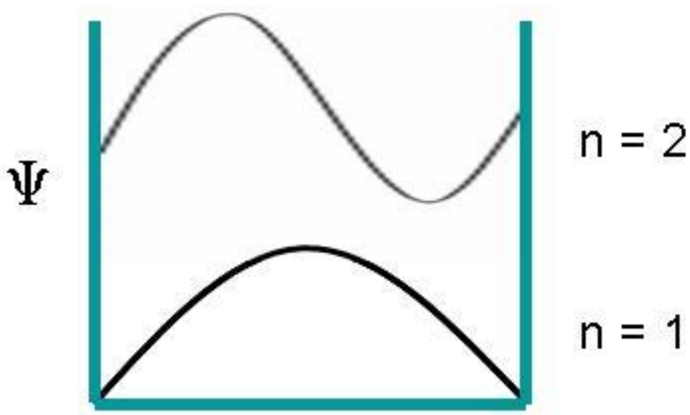
Solving for E results in the allowed energies for a particle in a box:

En=n2h28mL2(17)(17)En=n2h28mL2
This is an important result that tells us:

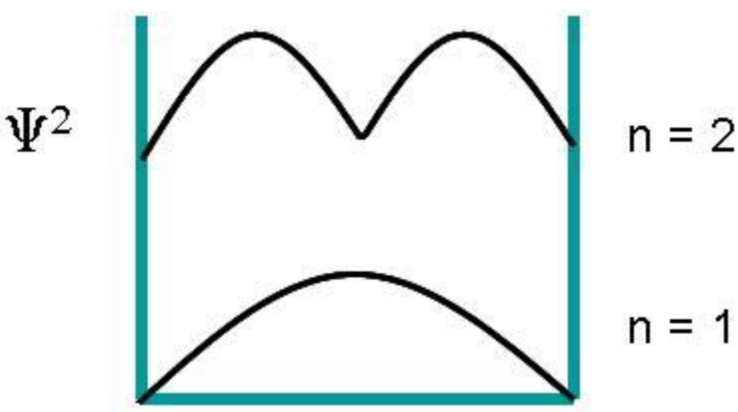
The energy of a particle is quantized and
The lowest possible energy of a particle is **NOT** zero. This is called the **zero-point energy** and means the particle can **never be at rest** because it always has some kinetic energy.

This is also consistent with the Heisenberg Uncertainty Principle: if the particle had zero energy, we would know where it was in both space and time.

The wavefunction for a particle in a box at the n=1n=1 and n=2n=2 energy levels look like this:



The probability of finding a particle a certain spot in the box is determined by squaring ψψ. The probability distribution for a particle in a box at the n=1n=1 and n=2n=2 energy levels looks like this:



Notice that the number of **nodes** (places where the particle has zero probability of being located) increases with increasing energy n. Also note that as the energy of the particle becomes greater, the quantum mechanical model breaks down as the energy levels get closer together and overlap, forming a continuum. This continuum means the particle is free and can have any energy value. At such high energies, the classical mechanical model is applied as the particle behaves more like a continuous wave. Therefore, the particle in a box problem is an example of Wave-Particle Duality.

IMPORTANT FACTS TO LEARN FROM THE PARTICLE IN THE BOX

- The energy of a particle is quantized. This means it can only take on discrete energy values.
- The lowest possible energy for a particle is **NOT** zero (even at 0 K). This means the particle *always* has some kinetic energy.
- The square of the wavefunction is related to the probability of finding the particle in a specific position for a given energy level.
- The probability changes with increasing energy of the particle and depends on the position in the box you are attempting to define the energy for.
- In classical physics, the probability of finding the particle is independent of the energy and the same at all points in the box.

UNIT – V

Digital Electronics

Digital Electronics: Decimal – binary – octal and hexadecimal numbers– their representation, inter-conversion, addition and subtraction, negative numbers. Sum of products – product of sums – their conversion – Simplification of Boolean expressions - K-Map – min terms – max terms - (2, 3 and 4 variables). Basic logic gates – AND, OR, NOT, NAND, NOR and EXOR gates – NAND and NOR as universal building gates – Boolean Algebra – Laws of Boolean Algebra – De Morgan's Theorems – Their verifications using truth tables.

Number Systems

There are infinite ways to represent a number. The four commonly associated with modern computers and digital electronics are: decimal, binary, octal, and hexadecimal.

Decimal (base 10) is the way most human beings represent numbers. Decimal is sometimes abbreviated as dec.

Decimal counting goes:
0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, and so on.

Binary (base 2) is the natural way most digital circuits represent and manipulate numbers. (Common misspellings are "bianary", "bienary", or "binery".) Binary numbers are sometimes represented by preceding the value with '0b', as in 0b1011. Binary is sometimes abbreviated as bin.

Binary counting goes:

0, 1, 10, 11, 100, 101, 110, 111, 1000, 1001, 1010, 1011, 1100, 1101, 1110, 1111, 10000, 10001, and so on.

Octal (base 8) was previously a popular choice for representing digital circuit numbers in a form that is more compact than binary. Octal is sometimes abbreviated as oct.

Octal counting goes:

0, 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, and so on.

Hexadecimal (base 16) is currently the most popular choice for representing digital circuit numbers in a form that is more compact than binary. (Common misspellings are “hexdecimal”, “hexidecimal”, “hexedecimal”, or “hexodecimal”.) Hexadecimal numbers are sometimes represented by preceding the value with '0x', as in 0x1B84. Hexadecimal is sometimes abbreviated as hex.

Hexadecimal counting goes:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F, 10, 11, and so on.

All four number systems are equally capable of representing any number. Furthermore, a number can be perfectly converted between the various number systems without any loss of numeric value.

At first blush, it seems like using any number system other than human-centric decimal is complicated and unnecessary. However, since the job of electrical and software engineers is to work with digital circuits, engineers require number systems that can best transfer information between the human world and the digital circuit world.

It turns out that the way in which a number is represented can make it easier for the engineer to perceive the meaning of the number as it applies to a digital circuit. In other words, the appropriate number system can actually make things less complicated.

Fundamental Information Element of Digital Circuits

Almost all modern digital circuits are based on two-state switches. The switches are either on or off. It doesn't matter if the switches are actually physical switches, vacuum tubes, relays, or transistors. And, it doesn't matter if the 'on' state is represented by 1.8 V on a cutting-edge CPU core, -12 V on a RS-232 interface chip, or 5 V on a classic TTL logic chip.

Because the fundamental information element of digital circuits has two states, it is most naturally represented by a number system where each individual digit has two states: binary.
For example, switches that are 'on' are represented by '1' and switches that are 'off' are represented by '0'. It is easy to instantly comprehend the values of 8 switches represented in binary as 10001101. It is also easy to build a circuit to display each switch state in binary, by having an LED (lit or unlit) for each binary digit.

Conversion of Numbers

Conversion of numbers from one system to another becomes necessary to understand the process and the logic of the operations of a computer system. It is not very difficult to convert numbers from one base to another. We will first discuss about the conversion of binary numbers to their decimal equivalents.

(i) Expansion Method:

In expansion method the conversion of binary numbers to their decimal equivalents are shown with the help of the examples.

1. Convert the decimal numbers to their binary equivalents:

(a) 256

Solution:

256

256	128	64	32	16	8	4	2	1
1	0	0	0	0	0	0	0	0

Since the given number 256 appears in the first row, we put 1 in the slot below 256 and fill all the other slots to the right of this slot with zeros.

Thus, $256_{10} = 100000000_2$

Addition and subtraction of octal numbers are explained using different examples.

Addition of octal numbers:

Addition of octal numbers is carried out by the same principle as that of decimal or binary numbers.

Evaluate:

(i) $(162)_8 + (537)_8$

Solution:

1 1 <---- carry

1 6 2

$\underline{5\ 3\ 7}$

7 2 1

Therefore, sum = 721_8

(ii) $(136)_8 + (636)_8$

Solution:

```
   1      <---- carry
  1 3 6
  6 3 6
 -------
  7 7 4
```

Therefore, sum = 774_8

(iii) $(25.27)_8 + (13.2)_8$

Solution:

```
  1          <---- carry
  2 5 . 2 7
  1 3 . 2
 -----------
  4 0 . 4 7
```

Therefore, sum = $(40.47)_8$

(iv) $(67.5)_8 + (45.6)_8$

Solution:

```
  1 1         <---- carry

  6 7 . 5

  4 5 . 6
 ---------
1 3 5 . 3
```

Therefore, sum = $(135.3)_8$

(b) 77

Solution:

77

(b) 77

Solution:

77

The given number is less than 128 but greater than 64. We therefore put 1 in the slot corresponding to 64 in the first row. Next, we subtract 64 from 77 and get 13 as remainder.

This remainder is less than 16 and greater than 8. So we put 1 in the slot corresponding to 8 and subtract 8 from 13. This gives 13 - 8 = 5. This remainder is greater than 4 and less than 8.

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Hence we put 1 in the slot corresponding to 4 and subtracting 4 from 5 we get 1. Now, 1 is present in the right hand most slot of the first row. We, therefore, put 1 in the corresponding slot and fill all other slots with zeros.

Thus, 7710 = 10011012.

Conversion of decimal fractions to binary fractions may also be accomplished by using similar method. Let us observe the procedure with the help of the following example:

2. Convert 0.67510 to its binary equivalent.

Solution:

Convert Decial Number to Binary Number

Subtract .5 from the given number to get .675 - .5 = .175 and place 1 in the slot corresponding to .5 of the first row.

Now the number .175 is less than .25 and greater than .125. So, we put 1 in the slot corresponding to the number .125 of the first row and subtract .125 from .175 to get .175 - .125 = .05. The remainder .05 is less than .0625 but greater than .03125.

Hence we put 1 in the slot corresponding to 0.3125 and the subtraction given .05 - .03125 = .01875 and continue the process. The other slots are then filled with zeros.

64	32	16	8	4	2	1
1	0	0	1	1	0	1

Thus, .67510 = (.10101…)2

The given number is less than 128 but greater than 64. We therefore put 1 in the slot corresponding to 64 in the first row. Next, we subtract 64 from 77 and get 13 as remainder.
This remainder is less than 16 and greater than 8. So we put 1 in the slot corresponding to 8 and subtract 8 from 13. This gives 13 - 8 = 5. This remainder is greater than 4 and less than 8.

(b) 77

Solution:

77

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Thus, 7710 = 10011012.

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Hence we put 1 in the slot corresponding to 0.3125 and the subtraction given .05 - .03125 = .01875 and continue the process. The other slots are then filled with zeros.

Thus, .67510 = $(.10101\ldots)_2$

Subtraction of octal numbers:

Similarly, subtraction of octal numbers can be performed by following the rules of subtraction of decimal numbers.

Thus, for performing addition and subtraction of octal numbers we can follow the rules of addition and subtraction of decimal numbers.

Boolean functions may be practically implemented by using electronic gates. The following points are important to understand.

Electronic gates require a power supply.

Gate **INPUTS** are driven by voltages having two nominal values, e.g. 0V and 5V representing logic 0 and logic 1 respectively.

The **OUTPUT** of a gate provides two nominal values of voltage only, e.g. 0V and 5V representing logic 0 and logic 1 respectively. In general, there is only one output to a logic gate except in some special cases.

There is always a time delay between an input being applied and the output responding.

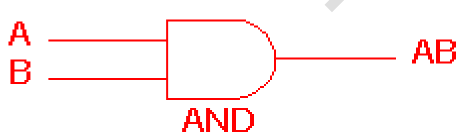
Truth Tables

Truth tables are used to help show the function of a logic gate. If you are unsure about truth tables and need guidence on how go about drawningthem for individual gates or logic circuits then use the truth table section link.

Logic gates

Digital systems are said to be constructed by using logic gates. These gates are the AND, OR, NOT, NAND, NOR, EXOR and EXNOR gates. The basic operations are described below with the aid of truth tables.

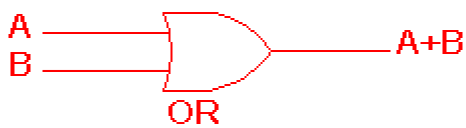
AND gate



2 Input AND gate		
A	B	A.B
0	0	0
0	1	0
1	0	0
1	1	1

The AND gate is an electronic circuit that gives a **high** output (1) only if **all** its inputs are high. A dot (.) is used to show the AND operation i.e. A.B. Bear in mind that this dot is sometimes omitted i.e. AB

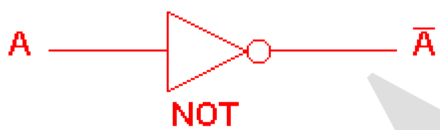
OR gate



2 Input OR gate		
A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

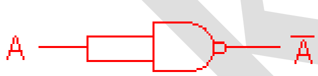
The OR gate is an electronic circuit that gives a high output (1) if **one or more** of its inputs are high. A plus (+) is used to show the OR operation.

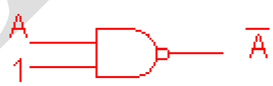
NOT gate



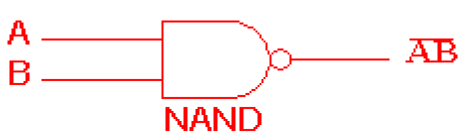
NOT gate	
A	$\overline{A}$
0	1
1	0

The NOT gate is an electronic circuit that produces an inverted version of the input at its output. It is also known as an *inverter*. If the input variable is A, the inverted output is known as NOT A. This is also shown as A', or A with a bar over the top, as shown at the outputs. The diagrams below show two ways that the NAND logic gate can be configured to produce a NOT gate. It can also be done using NOR logic gates in the same way.





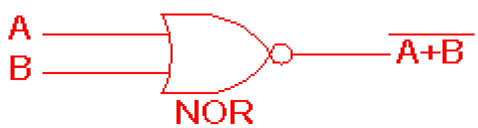
NAND gate



2 Input NAND gate		
A	B	$\overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

This is a NOT-AND gate which is equal to an AND gate followed by a NOT gate. The outputs of all NAND gates are high if **any** of the inputs are low. The symbol is an AND gate with a small circle on the output. The small circle represents inversion.

NOR gate

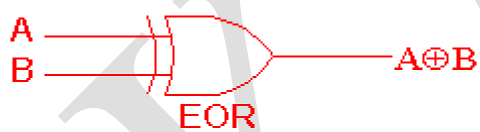


2 Input NOR gate		
A	B	$\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

This is a NOT-OR gate which is equal to an OR gate followed by a NOT gate. The outputs of all NOR gates are low if **any** of the inputs are high.

The symbol is an OR gate with a small circle on the output. The small circle represents inversion.

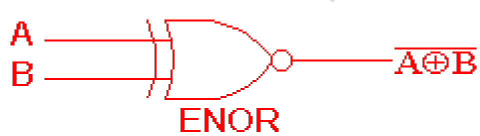
EXOR gate



2 Input EXOR gate		
A	B	$A \oplus B$
0	0	0
0	1	1
1	0	1
1	1	0

The '**Exclusive-OR**' gate is a circuit which will give a high output if **either, but not both**, of its two inputs are high. An encircled plus sign ($\oplus$) is used to show the EOR operation.

EXNOR gate



2 Input EXNOR gate		
A	B	$\overline{A \oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1

The '**Exclusive-NOR'** gate circuit does the opposite to the EOR gate. It will give a low output if **either, but not both**, of its two inputs are high. The symbol is an EXOR gate with a small circle on the output. The small circle represents inversion.

The NAND and NOR gates are called *universal functions* since with either one the AND and OR functions and NOT can be generated.

Note:

A function in *sum of products* form can be implemented using NAND gates by replacing all AND and OR gates by NAND gates.

A function in *product of sums* form can be implemented using NOR gates by replacing all AND and OR gates by NOR gates.

Table 1: Logic gate symbols

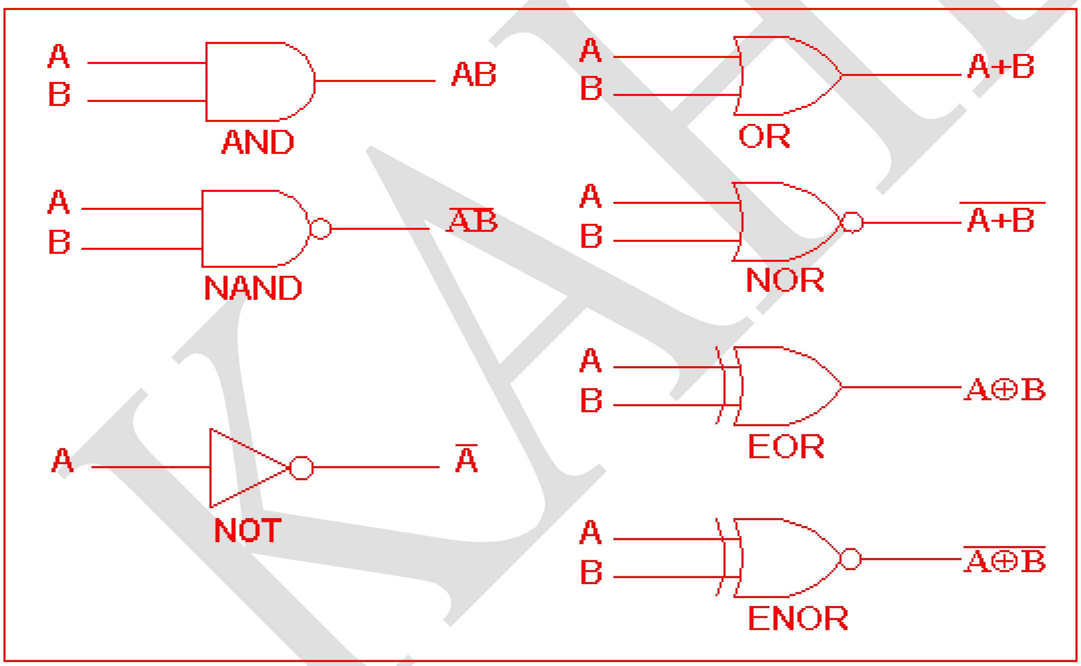


Table 2 is a summary truth table of the input/output combinations for the NOT gate together with all possible input/output combinations for the other gate functions. Also note that a truth table with 'n' inputs has 2^n rows. You can compare the outputs of different gates.

Table 2: Logic gates representation using the Truth table

NOT gate	
A	$\bar{A}$
0	1
1	0

INPUTS		OUTPUTS					
A	B	AND	NAND	OR	NOR	EXOR	EXNOR
0	0	0	1	0	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	0	1	0	0	1

Universal Gate | NAND and NOR Gate as Universal Gates

We have discussed different types of logic gates in previous articles. Now coming to the topic of this article we are going to discuss the **Universal Gate**. AND, NOT and OR gates are the basic gates; we can create any logic gate or any Boolean expression by combining a mixture of these gates.

But NOR gates and NAND gates have the particular property that any **one of them** can create any logical Boolean expression if appropriately designed. Meaning that you can create any logical Boolean expression using ONLY NOR gates or ONLY NAND gates. Other logical gates do not have this property. If you which to play around with these universal gates as part of an electronics project, many of the best Arduino starter kits contain these universal NOR and

NAND gates.

Now we will look at the operation of NOR gates and NAND gates as **universal gates**.

NAND gate as Universal Gate

The below diagram is of a two input NAND gate. The first part is an AND gate and second part is a dot after it represents a NOT gate. So it is clear that during the operation of NAND gate, the

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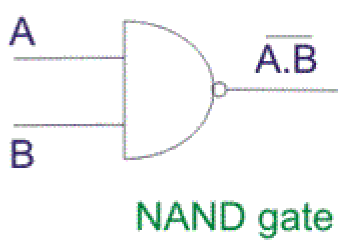
inputs are first going through AND gate and after that, the output gets reversed, and we get the final output. Now we will look at the truth table of NAND gate.

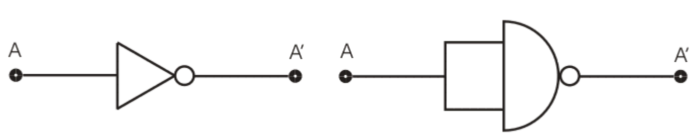
We will consider the truth table of the above NAND gate i.e. a two-input gate. The two inputs are A and B.



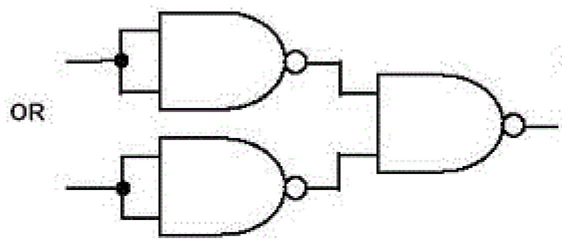
truth table of a nand gate

Inputs		Output
A	B	$X = \overline{A.B}$
0	0	1
0	1	1
1	0	1
1	1	0

Now we will see how this gate can be used to make other gates.



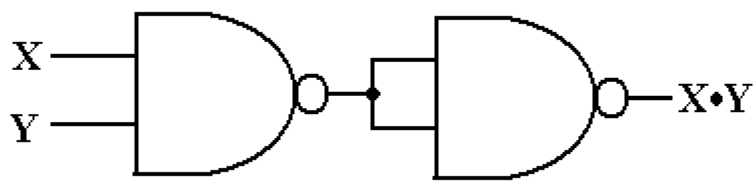
This is the circuit diagram of a NAND gate used to make work like a NOT gate, the original logic gate diagram of NOT gate is given besides.



A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

The above diagram is of an OR gate made from combinations of NAND gates, arranged in a proper manner. The truth table of an OR gate is also given beside the diagram.

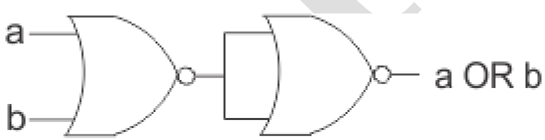
Now we will see the design of an AND gate from NAND gates.



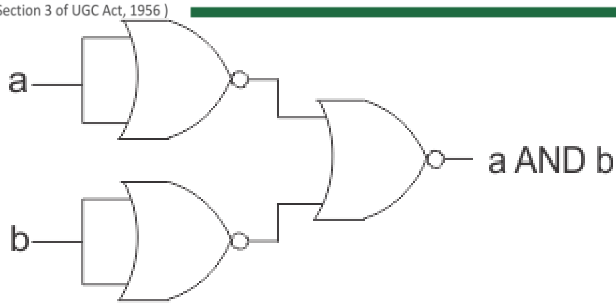
The above diagram is of an AND gate made from NAND gate. So we can see that all the three basic gates can be made by only using NAND gates, that’s why this gate is called **Universal Gate**, and it is appropriate.

NOR gate as universal gate

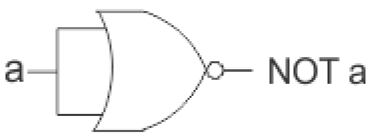
We have seen how NAND gate can be used to make all the three basic gates by using that alone. Now we will discuss the same in case of NOR gate.



The above diagram is of an OR gate made by only using NOR gates. The output of this gate is exactly similar to that of a single OR gate. We can see the circuit arrangement of OR gate using, NOR gate is similar to that of AND gate using NAND gates.



The above diagram as the name suggests is of AND gate using only NOR gate, again we can see that the circuit diagram of AND gate using only NOR gate is exactly similar to that of OR gate using only NAND gates. Now we will finally see how we can make a NOT gate by using only NOR gates.



The above diagram is of a NOT gate made by using a NOR gate. The circuit diagram is similar to that of NOT gate made by using only NAND gate.
So, from the above discussion, it is clear that all the three basic gates (AND, OR, NOT) can be made by only using NOR gate. And thus, it can be aptly termed as **Universal Gate**.

Laws of Boolean Algebra

As well as the logic symbols “0” and “1” being used to represent a digital input or output, we can also use them as constants for a permanently “Open” or “Closed” circuit or contact respectively.

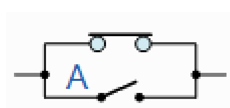
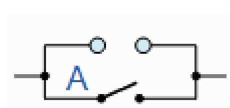
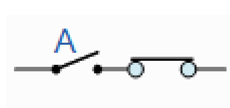
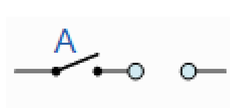
A set of rules or Laws of Boolean Algebra expressions have been invented to help reduce the number of logic gates needed to perform a particular logic operation resulting in a list of functions or theorems known commonly as the **Laws of Boolean Algebra**.

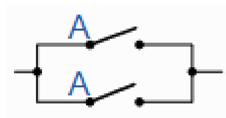
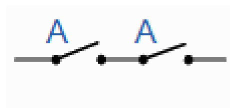
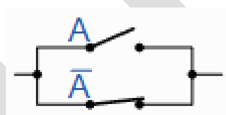
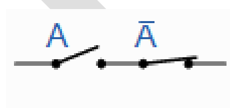
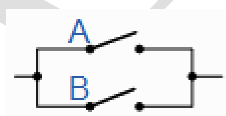
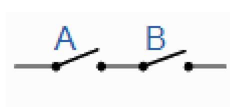
Boolean Algebra is the mathematics we use to analyse digital gates and circuits. We can use these “Laws of Boolean” to both reduce and simplify a complex Boolean expression in an attempt to reduce the number of logic gates required. *Boolean Algebra* is therefore a system of mathematics based on logic that has its own set of rules or laws which are used to define and reduce Boolean expressions.

The variables used in **Boolean Algebra** only have one of two possible values, a logic “0” and a logic “1” but an expression can have an infinite number of variables all labelled individually to represent inputs to the expression, For example, variables A, B, C etc, giving us a logical expression of A + B = C, but each variable can ONLY be a 0 or a 1.

Examples of these individual laws of Boolean, rules and theorems for Boolean Algebra are given in the following table.

Truth Tables for the Laws of Boolean

Boolean Expression	Description	Equivalent Switching Circuit	Boolean Algebra Law or Rule
A + 1 = 1	A in parallel with closed = "CLOSED"		Annulment
A + 0 = A	A in parallel with open = "A"		Identity
A . 1 = A	A in series with closed = "A"		Identity
A . 0 = 0	A in series with open = "OPEN"		Annulment

A + A = A	A in parallel with A = "A"		Idempotent
A . A = A	A in series with A = "A"		Idempotent
NOT A = A	NOT NOT A (double negative) = "A"		Double Negation
A + A = 1	A in parallel with NOT A = "CLOSED"		Complement
A . A = 0	A in series with NOT A = "OPEN"		Complement
A+B = B+A	A in parallel with B = B in parallel with A		Commutative
A.B = B.A	A in series with B = B in series with A		Commutative
A+B = A.B	invert and replace OR with AND		de Morgan's Theorem
A.B = A+B	invert and replace AND with OR		de Morgan's Theorem

Laws of Boolean Algebra

The basic **Laws of Boolean Algebra** that relate to the *Commutative Law* allowing a change in position for addition and multiplication, the *Associative Law* allowing the removal of brackets for addition and multiplication, as well as the *Distributive Law* allowing the factoring of an expression, are the same as in ordinary algebra.

Each of the *Boolean Laws* above are given with just a single or two variables, but the number of variables defined by a single law is not limited to this as there can be an infinite number of variables as inputs too the expression. These Boolean laws detailed above can be used to prove any given Boolean expression as well as for simplifying complicated digital circuits.

A brief description of the various **Laws of Boolean** are given below with A representing a variable input.

Description of the Laws of Boolean Algebra

A + (B + C) = (A + B) + C = A + B + C (OR Associate Law)

A(B.C) = (A.B)C = A . B . C (AND Associate Law)

(1) Two separate terms NOR´ed together is the same as the two terms inverted (Complement) and AND´ed for example: A+B = A . B

(2) Two separate terms NAND´ed together is the same as the two terms inverted (Complement) and OR´ed for example: A.B = A + B

Other algebraic Laws of Boolean not detailed above include:

Distributive Law – This law permits the multiplying or factoring out of an expression.

A(B + C) = A.B + A.C (OR Distributive Law)

A + (B.C) = (A + B).(A + C) (AND Distributive Law)

Absorptive Law – This law enables a reduction in a complicated expression to a simpler one by absorbing like terms.

A + (A.B) = A (OR Absorption Law)

A(A + B) = A (AND Absorption Law)

Associative Law – This law allows the removal of brackets from an expression and regrouping of the variables.

A + (B + C) = (A + B) + C = A + B + C (OR Associate Law)

A(B.C) = (A.B)C = A . B . C (AND Associate Law)

Boolean Algebra Functions

Using the information above, simple 2-input AND, OR and NOT Gates can be represented by 16 possible functions as shown in the following table.

Function	Description	Expression
1.	NULL	0
2.	IDENTITY	1
3.	Input A	A
4.	Input B	B
5.	NOT A	A
6.	NOT B	B
7.	A AND B (AND)	A . B
8.	A AND NOT B	A . B

9.	NOT A AND B	A . B
10.	NOT AND (NAND)	A . B
11.	A OR B (OR)	A + B
12.	A OR NOT B	A + B
13.	NOT A OR B	A + B
14.	NOT OR (NOR)	A + B
15.	Exclusive-OR	A . B + A . B
16.	Exclusive-NOR	A . B + A . B

Laws of Boolean Algebra Example No1

Using the above laws, simplify the following expression: (A + B)(A + C)

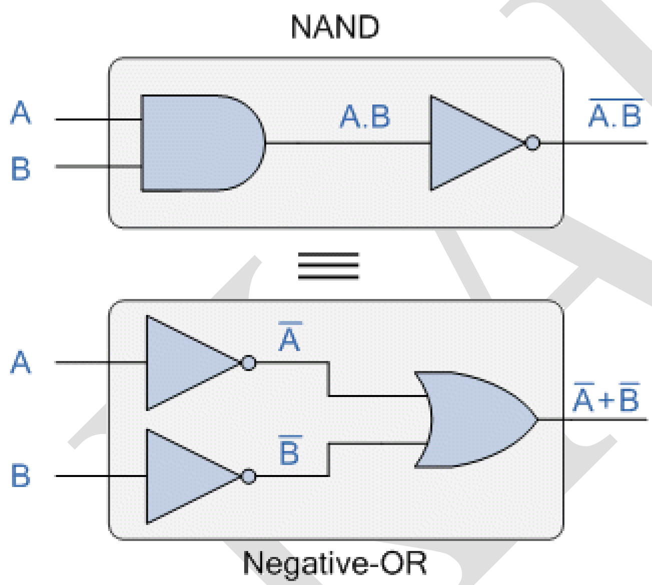
	Q =	(A + B).(A + C)
	A.A + A.C + A.B + B.C	– Distributive law
	A + A.C + A.B + B.C	– Idempotent AND law (A.A = A)
	A(1 + C) + A.B + B.C	– Distributive law
	A.1 + A.B + B.C	– Identity OR law (1 + C = 1)
	A(1 + B) + B.C	– Distributive law

	A.1 + B.C	– Identity OR law (1 + B = 1)
	A + (B.C)	– Identity AND law (A.1 = A)

Then the expression: (A + B)(A + C) can be simplified to A + (B.C) as in the Distributive law.

DeMorgan's Theorem

DeMorgan´s Theorem and Laws can be used to to find the equivalency of the NAND and NOR gates



As we have seen previously, Boolean Algebra uses a set of laws and rules to define the operation of a digital logic circuit with "0's" and "1's" being used to represent a digital input or output condition. Boolean Algebra uses these zeros and ones to create truth tables and mathematical expressions to define the digital operation of a logic AND, OR and NOT (or inversion) operations as well as ways of expressing other logical operations such as the XOR (Exclusive-OR) function.

While George Boole's set of laws and rules allows us to analyise and simplify a digital circuit, there are two laws within his set that are attributed to **Augustus DeMorgan** (a nineteenth century English mathematician) which views the logical NAND and NOR operations as separate NOT AND and NOT OR functions respectively.

But before we look at **DeMorgan's Theory** in more detail, let's remind ourselves of the basic logical operations where A and B are logic (or Boolean) input binary variables, and whose values can only be either "0" or "1" producing four possible input combinations, 00, 01, 10, and 11.

Truth Table for Each Logical Operation

Input Variable		Output Conditions			
A	B	AND	NAND	OR	NOR
0	0	0	1	0	1
0	1	0	1	1	0
1	0	0	1	1	0
1	1	1	0	1	0

The following table gives a list of the common logic functions and their equivalent Boolean notation where a "." (a dot) means an AND operation, a "+" (plus sign) means an OR operation, and the complement or inverse of a variable is indicated by a bar over the variable.

Logic Function	Boolean Notation

AND	A.B
OR	A+B
NOT	A
NAND	A .B
NOR	A+B

DeMorgan’s Theory

DeMorgan’s Theorems are basically two sets of rules or laws developed from the Boolean expressions for AND, OR and NOT using two input variables, A and B. These two rules or theorems allow the input variables to be negated and converted from one form of a Boolean function into an opposite form.

DeMorgan’s first theorem states that two (or more) variables NOR´ed together is the same as the two variables inverted (Complement) and AND´ed, while the second theorem states that two (or more) variables NAND´ed together is the same as the two terms inverted (Complement) and OR´ed. That is replace all the OR operators with AND operators, or all the AND operators with an OR operators.

DeMorgan’s First Theorem

DeMorgan’s First theorem proves that when two (or more) input variables are AND’ed and negated, they are equivalent to the OR of the complements of the individual variables. Thus the equivalent of the NAND function and is a negative-OR function proving that A.B = A+B and we can show this using the following table.

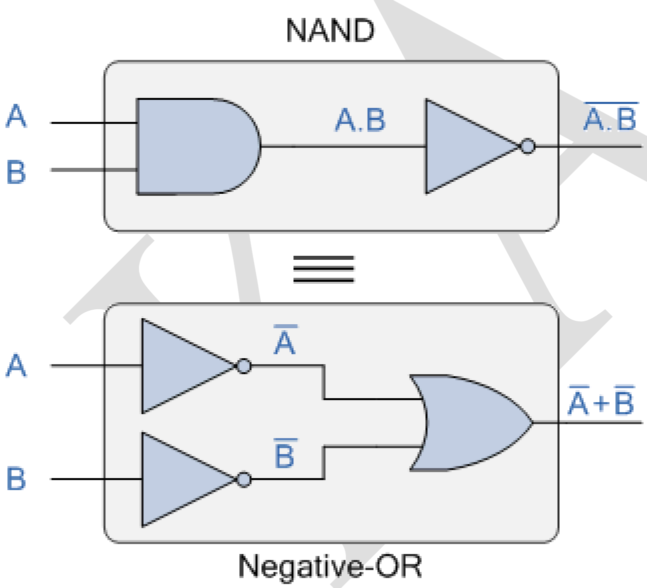
Verifying DeMorgan’s First Theorem using Truth Table

Inputs	Truth Table Outputs For Each Term

B	A	A.B	A.B	A	B	A + B
0	0	0	**1**	1	1	**1**
0	1	0	**1**	0	1	**1**
1	0	0	**1**	1	0	**1**
1	1	1	**0**	0	0	**0**

We can also show that A.B = A+B using logic gates as shown.

DeMorgan's First Law Implementation using Logic Gates



The top logic gate arrangement of: A.B can be implemented using a NAND gate with inputs A and B. The lower logic gate arrangement first inverts the two inputs producing A and B which become the inputs to the OR gate. Therefore the output from the OR gate becomes: A+B

Thus an OR gate with inverters (NOT gates) on each of its inputs is equivalent to a NAND gate function, and an individual NAND gate can be represented in this way as the equivalency of a NAND gate is a negative-OR.

DeMorgan’s Second Theorem

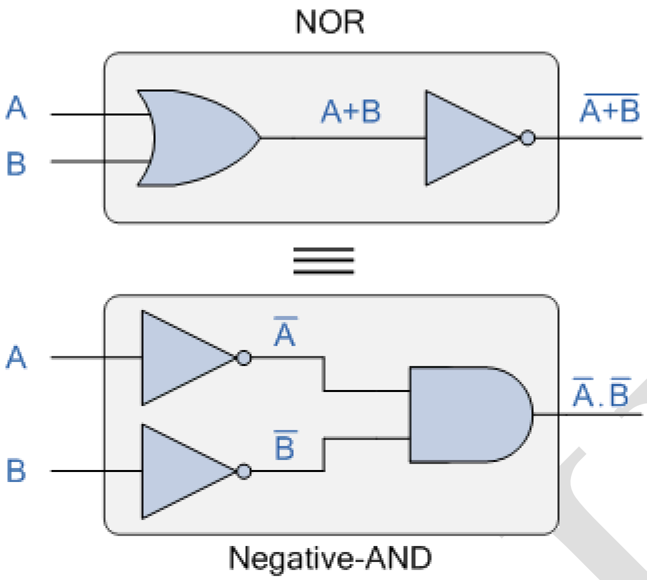
DeMorgan’s Second theorem proves that when two (or more) input variables are OR’ed and negated, they are equivalent to the AND of the complements of the individual variables. Thus the equivalent of the NOR function and is a negative-AND function proving that A+B = A.B and again we can show this using the following truth table.

Verifying DeMorgan’s Second Theorem using Truth Table

Inputs		Truth Table Outputs For Each Term				
B	A	A+B	A+B	A	B	A . B
0	0	0	**1**	1	1	**1**
0	1	1	**0**	0	1	**0**
1	0	1	**0**	1	0	**0**
1	1	1	**0**	0	0	**0**

We can also show that A+B = A.B using logic gates as shown.

DeMorgan’s Second Law Implementation using Logic Gates



The top logic gate arrangement of: A+B can be implemented using a NOR gate with inputs A and B. The lower logic gate arrangement first inverts the two inputs producing A and B which become the inputs to the AND gate. Therefore the output from the AND gate becomes: A.B

Thus an AND gate with inverters (NOT gates) on each of its inputs is equivalent to a NOR gate function, and an individual NOR gate can be represented in this way as the equivalency of a NOR gate is a negative-AND.

Although we have used DeMorgan's theorems with only two input variables A and B, they are equally valid for use with three, four or more input variable expressions, for example:

For a 3-variable input

A.B.C = A+B+C

and also

A+B+C = A.B.C

For a 4-variable input

A.B.C.D = A+B+C+D

and also

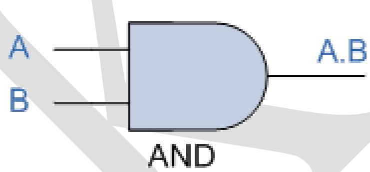
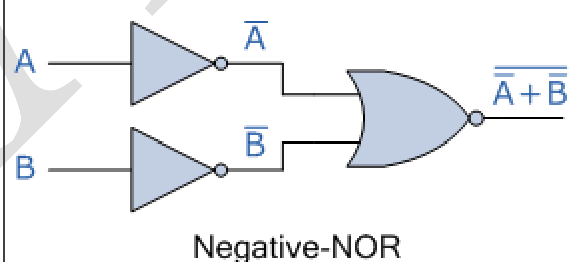
A+B+C+D = A.B.C.D

and so on.

DeMorgan's Equivalent Gates

We have seen here that DeMorgan's Theorems replace all of the AND (.) operators with OR (+) and vice versa and then complements each of the terms or variables in the expression by inverting it, that is 0's to 1's and 1's to 0's before inverting the entire function. Thus to obtain the DeMorgan equivalent for an AND, NAND, OR or NOR gate, we simply add inverters (NOT-gates) to all inputs and outputs and change an AND symbol to an OR symbol or change an OR symbol to an AND symbol as shown in the following table.

DeMorgan's Equivalent Gates

<table>
<tr><th>Standard Logic Gate</th><th>DeMorgan's Equivalent Gate</th></tr>
<tr><td>
</td><td>
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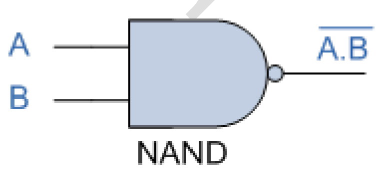
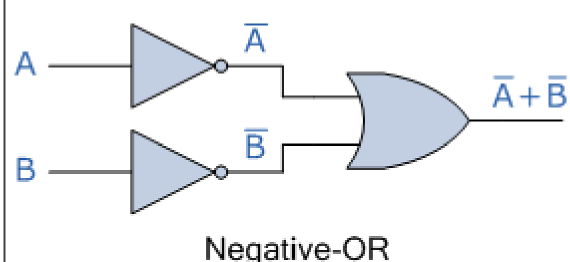
<tr><td>
</td><td>
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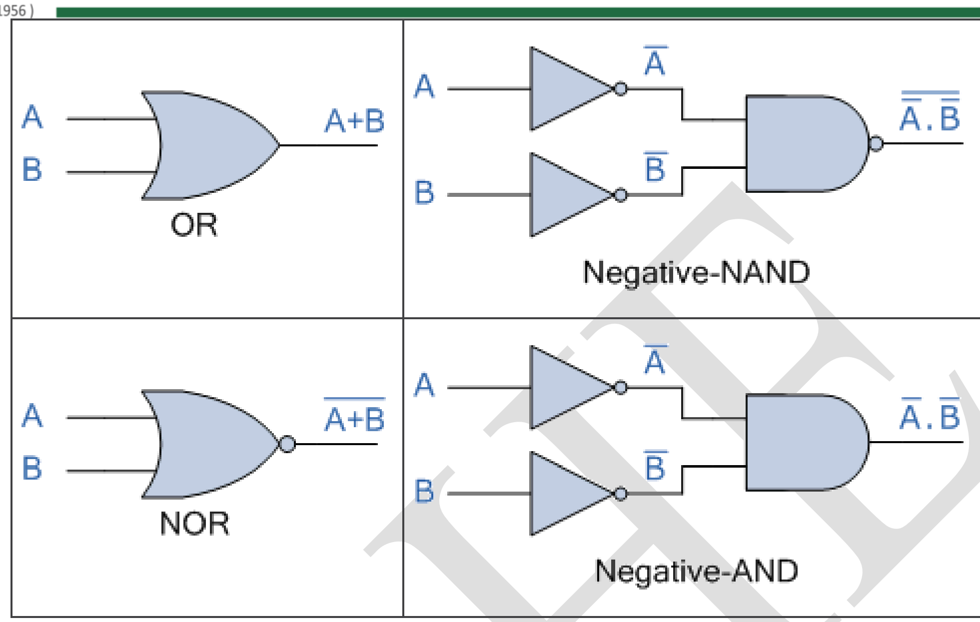

Then we have seen that the complement of two (or more) AND'ed input variables is equivalent to the OR of the complements of these variables, and that the complement of two(or more) OR'ed variables is equivalent to the AND of the complements of the variables as defined by *DeMorgan*.

[19MMU203]
KARPAGAM ACADEMY OF HIGHER EDUCATION, COIMBATORE - 641 021
(Under Section 3 of UGC Act 1956)
(For the candidates admitted from 2019 onwards)

B. Sc., DEGREE EXAMINATIONS, APRIL - 2020
Second Semester
DEPARTMENT OF MATHEMATICS
PHYSICS - II

QUESTIONS	OPTION 1	OPTION 2	OPTION 3	OPTION 4	ANSWER
UNIT-I					
If the distance between two charge is doubled the electrostatic force between the charge will be______	fourtime more	four time less	will increase into two times	will decrease into two times	four time less
The field due to a wire of uniform charge density at a perpendicular distance y from it	increases with increase in y	decrease with increaase in y	remains constant	depends upon the length of the wire	decrease with increaase in y
Field due to a uniformly charged ring at an axial point at distance very large as compared to the radius of the ring	independent of x	directly proportional to x	directly proportional to x^2	inversely proportional to x^2	inversely proportional to x^2
Electric charge enclosed by Gaussian surface is	0	1	min	max	0
For gauss's law point charges in closed surface must be distributed	arbitrarily	sequentially	rational	in line	arbitrarily
Electric field intensity outside two charged parallel plate is	$\sigma/2\varepsilon_0$	σ/ε_0	infinity	0	0
The total electric flux over any closed surface is	ε_0	σ/ε_0	ε_0/σ	q/ε_0	q/ε_0
Electric flux lines due to an infinite sheet of charge is	converging	radial	uniform and perpendicular to the sheet	uniform and parallel to the sheet	uniform and perpendicular to the sheet
One electron volt is __________.	1.6×10^{-19}joule	1.6 x 10-19volt	1.6 x 10-19joule	1.6 x 10 -21joule	1.6×10^{-19}joule
_________ law establishes a relationship between the electric flux and the electrostatic charge.	Lenz's	Keplers	Faraday	Gauss's	Gauss's
The ratio ϵ/ϵ_0 is a dimensionless quantity known as ________	relative permeability	relative permittivity	absolute permittivity	permeability	relative permittivity
The electric field lines begin at the __________ charge and terminate at the _________ charge.	positive, negative	negative, positive	both positive	both negative	positive, negative
Total electric flux emanating from a charge q coulomb placed in air is ____________.	q/ϵ_0	$\epsilon_0 q$	q	$4\pi q$	q/ϵ_0
Gauss's law due to different charge distribution is used to calculate	electric field	electric charge	electric intensity	electric field lines.	electric intensity
The total flux across a closed surface enclosing charge is independent of	shape of the closed surface		volume of the enclosure	actual spatial argument of charges within the surface	all

The unit of Electric flux is __________.	Gauss's	Weber	$Nm^{-2}c^{-1}$	Nc^{-1}	$Nm^{-2}c^{-1}$
.Mechanical pressure on the surface of a charged conductor having surface charge density σ is __________.	$\epsilon_0 \sigma^2$	σ^2 / ϵ_0	$\sigma^2 / 2\epsilon_0$	$\sigma / 2\epsilon_0$	$\sigma^2 / 2\epsilon_0$
If the separation between two charges is increased the electric potential energy	always decreases	always increases	remains the same	may increase or decrease	may increase or decrease
Electric intensity due to an infinitely long plane sheet of a conductor at appoint close to its surface is	independent of r	proportional to $1/r^2$	proportional to r	inversely proportional to 1/r	independent of r
The total electric flux through a closed surface depends on	location of the charge only	the shape of the closed surface only	the value of the net charge only	both charge and shape	the value of the net charge only
Electric field intensity due to an infinite plane sheet of charge is	σ/ε_0	$q/2\varepsilon_0$	$\sigma/2\varepsilon_0$	q/ε_0	$\sigma/2\varepsilon_0$
Law stated as flux is $^1/_{E_0}$ times total charge is	ohms law	newton's law	gauss's law	coulombs law.	gauss's law
A Gaussian sphere closes an electric dipole within it. Then the total flux through the sphere is	half due to a single charge	double due to a single charge	zero	dependent on the position of the dipole	zero
The Flux of electric field is____	scalar	vector	zero	infinity	scalar
Flux density is measured in	Tesla	Weber	Ampere- turn	Maxwell	Tesla
Which of the following quantities are scalar?	dipole moment	electric force	electric field	electric potential	electric potential
A dipole is placed in a uniform electric field with its axis parallel to the field. It experiences	only a net force	only a torque	both a net force and torque	neither a net force nor a torque	neither a net force nor a torque
Electric potential energy U of two point charges is	$q_1q_2/4\varepsilon_0\pi r^2$	$q_1q_2/4\varepsilon_0\pi r$	pEsinθ	pEcosθ	$q_1q_2/4\varepsilon_0\pi r$
If a point lies at a distance x from the midpoint of the dipole, the electric potential at the point is proportional to	$1/x^2$	$1/x^3$	$1/x^4$	$1/x^{3/2}$	$1/x^2$
The law that governs the force between electric charge is called	Amperes	Coulomb law	Faraday	Ohms	Coulomb law
The minimum value of the charge in any object cannot be less than	1.6 x $10^{-19coulomb}$	3.2 x $10^{-19\ Coulomb}$	4.8 x $10^{-19Coulomb}$	1 coulomb	1.6 x $10^{-19coulomb}$
An electric field can deflect	X rays	neutrons	alpha particle	gamma rays	alpha particle
Inside the hollow spherical conductor, the potential	is constant	varies directly as the distance from the centre	varies inversely as the distance from the centre	varies inversely as the square of the distance from the centre	is constant
The intensity at a point due to a charge is inversely proportional to	amount of the charge	size of the charge	distance of the point	square of the distance from the charge	square of the distance from the charge
The distance between two charge is douled then the force between them would become	half	one-fourth	doubled	four times	one-fourth
A surface enclosed an electric dipole, the flux through the surface is	infinite	positive	negative	zero	zero

Electric potential is a	vector quantity	scalar quantity	neither vector nor scalar	fictitious quantity	scalar quantity
The potential at any point inside a charged sphere is	zero	same as potential on the surface	smaller than the potential on the surface	greater than the potential on the surface	same as potential on the surface
Two smallspheres eaach carrying a charge q are placed r metre apart, one of the spheres is taken around the other one in a circular path, the work done will be equal to	force between them x r	force between them x 2r	force between them / 2nr	zero	zero
State which of the following is correct?	J=Coulomb x volt	J=Coulomb / volt	J= volt/ ampere	J= volt x ampere	J=Coulomb x volt
A positively charged glass rod attracts an object. The object must be	negatively charged	either negative charged or neutral	neutral	positively charged	either negative charged or neutral
A charge q islocated at the centre of a hypothetical cube. The electric flux through any face of the cube is	q/ϵ0	q/2ϵ0	q/4ϵ0	q/4ϵ0	q/4ϵ0
The force between two electrons seperated by a distance r varies as	r^2	relative permittivity	r^-1	r^-2	r^-2
The energy stored per unit volume of the medium of relative permittivity is ______________.	$\epsilon_r\epsilon_0E^2/2$	$\epsilon_0E^2/2$	$\epsilon_r\epsilon_0E/2$	$\epsilon_0E/2$	$\epsilon_r\epsilon_0E^2/2$
All magnetic moments within a domain will point in the __________ direction.	Different	Same	Positive	Negative	Same
The electrical energy consumed by a coil is stored in the form of:	magnetic field	force field	electrostatic field	electrical field	magnetic field
Electricity may be generated by a wire:	carrying current	wrapped as a coil	passing through a flux field	that has neutral domains	passing through a flux field
A magnetic field has:	lines of reluctance	polar fields	lines of force	magnetomotive force	lines of force
The polarity of induced voltage while a field is collapsing is	opposite to the force creating it	independent of the force creating it	identical to the force creating the field	present only if the force is stationary	opposite to the force creating it
What is magnetic flux?	the number of lines of force in webers	the number of lines of force in maxwells	the number of lines of force in flux density	the number of lines of force in teslas	the number of lines of force in webers
The energy stored in the charged capacitor is _________.	$1/2\ CV^2$	1/2qV	v/q	qV	$1/2\ CV^2$
The arrangement in which one conductor is charged and other is earthed is named as ____________.	capacitor	condenser	capacitor/ condneser	comparator	capacitor/ condneser
__________ device is useful to reduce voltage fluctuations in electric power supplies.	capacitor	condenser	converter	comparator	capacitor
The capacitance of a capacitor C is___________	q/v	qv	v/q	v/q	q/v
_______capacitors can bewidely used in the tuning circuits of radio receivers.	mica	electrolytic	paper	variable air	variable air
_______capacitors are used widely in a radia-set as a smoothing capacitors	electrolytic	mica	both mica and electrolytic	variable	both mica and electrolytic
________capacitor is used in a.c bridges	electrolytic	variable air capacitor	both mica and electrolytic	mica	variable air capacitor

___________ device is used to measure electrostatic potentials	electrometers	magnetometers	potentiometer	galvanometer	electrometers
A dielectric slab is introduced between the plates of an isolated charged parallel plate air capacitor.Which of the following quantities will remain unchanged?	charge on the capacitor	p.d across the capacitor	energy of the capacitor	electric field inside the capacitor	charge on the capacitor
The p.d across a capacitor is kept constant.If a dielectric slab of dielectric constant K is introduced between the plates,the stored energy will be __________.	decreases by a factor K	increases by a factor K	remains constant	increases or decreases depending on the nature of the	increases by a factor K
Capacitance has the dimension ____________.	$M^{-1}L^{-2}T^{4}I^{2}$	$ML^{2}T^{-4}I^{-2}$	$MLT^{-3}I^{-1}$	$M^{-1}L^{-1}T^{3}I$	$M^{-1}L^{-2}T^{4}I^{2}$
In gauss's law the electric flux E through a closed surface (s) depends on the value of net charge __________.	Inside the surface	outside the surface	on the surface	in the surface	Inside the surface
The unit of capacitance is ____________.	Farad	coulomb/volt	Farad and Coulomb/Volt	ohm	Farad and Coulomb/Volt
_________ device is used to generate and detect electromagnetic oscillation of high frequency.	capacitor	voltmeter	Resistor	galvanometer	capacitor
The normal component of D are ________________ across the boundary by the surface charge density	continuous	Discontinuous	Random	Discrete	Discontinuous
The tangential component of the electric field is __________ across the boundary.	continuous	Discontinuous	Random	Discrete	continuous
The potential difference between the conductors is proportional to the _______________ on the capacitor.	charge	voltage	current	time	charge
The coaxial cable used in communication system is a common example for which type of capacitor __________.	spherical	cylindrical	Air capacitor	Parallel plate capacitor	Parallel plate capacitor
Variable air capacitor is used in _____________.	A.c bridges	D.c bridges	both a and b	tuning circuits	A.c bridges
_________ capacitors can be used only in unidirectional power supplies.	mica	Electrolytic	paper	variable	Electrolytic
An electron- volt (eV) is a unit of	Energy	Potential difference	Charge	Momentum	Energy
Farad is the unit of	capacitance	self inductance	mutual inductance	conductance of an electrolyte	capacitance
In a charged capacitor the energy is stored in	the field between the plates	positive chaarge	negative charge	neutral	the field between the plates
No current flows between two charged bodies connected together when they have the same	charge	potential	capacitance	resistance	potential
Dielectric materials are	insulating materials	semiconducting materials	magnetic materials	ferroelectric materials	insulating materials
Dielectric constant of vacuum is	infinity	100	one	zero	one
For making a capacitor it is better to select a dielectic having	low permittivity	high permitivitty	permitivity same as that of air	permitivity slightly more thanair	high permitivitty
A dielectric material must be a	resistor	insulator	good conductor	semi conductor	insulator

Which of the following material has highest value of dielectric constant	glass	vacuum	ceramics	oil	ceramics
When a dielectric slab is introduced in a parallel plate capacitor, the potential difference between the plates will	remain unchanged	decrease	increases	becomes zero	decrease
A capacitor consists of	two insulators seperated by a condenser	two conductors seperated by an insulator	2 insulator	2 conductor	two conductors seperated by an insulator

Unit-II

Which of the following material requires least magnetizing field to magnetize it?	Gold	Silver	Tungsten	Cobalt	Cobalt
Basic source of magnetism _______________	Charged particles alone	Movement of charged particles	Magnetic dipoles	Magnetic domains	Movement of charged particles
Units for magnetic flux density	Wb / m^2	Wb / A.m	A / m	Tesla / m	Wb / m^2
Magnetic permeability has units as	Wb / m^2	Wb / A.m	A / m	Tesla / m	Wb / A.m
Magnetic field strength’s units are	Wb / m^2	Wb / A.m	A / m	Tesla / m	A / m
Example for dia-magnetic materials	super conductors	alkali metals	transition metals	Ferrites	super conductors
Example for ferro-magnetic materials	super conductors	alkali metals	transition metals	Ferrites	alkali metals
Example for anti-ferro-magnetic materials	salts of transition elements	rare earth elements	transition metals	Ferrites	rare earth elements
Example for ferri-magnetic materials	salts of transition elements	rare earth elements	transition metals	Ferrites	transition metals
Magnetic susceptibility para-magnetic materials is	0.00001	-10^-5	10^5	10^-5 to 10^-2	0.00001
Magnetic susceptibility dia--magnetic materials is	0.00001	-10^-5	10^5	10^-5 to 10^-2	10^-5 to 10^-2
Magnetic susceptibility ferro-magnetic materials is	0.00001	-10^-5	10^5	10^-5 to 10^-2	10^-5 to 10^-2
Typical size of magnetic domains ______ (mm)	1 to 10	0.1-1	0.05	0.001	0.001
Example for magnetic material used in data storage devices	45 Permalloy	CrO2	Cunife	Alnico	CrO2
Susceptibility of a magnetic material is defined as the ratio of _________ induced in material to magnetic field intensity (H)	Intensity of magnetization	magnetizing field	magntic induction	Conductivity	Intensity of magnetization
Those substances which are weakly magnetized in the direction opposite to that of the external magnetic field are called as ___________	ferromagnetic substances	diamagnetic	paramagnet	anti ferro	diamagnetic

The magnetic field that exists in vacuum and induces magnetism is called _____________	magnetic intensity	magnetizing field	magnetic field intensity	magnetization	magnetizing field
The temperature at which the domain structure gets destroyed and ferromagnetic substance is converted into paramagnetic substance is called as ___________	zeropoint temp.	high temperature	curie temperature	domain thoery	curie temperature
The ability of magnetizing field to magnetize a material medium is called ____________	magnetic intensity	magnetic field	magnetic field intensity	magnetization	magnetic field intensity
Relative Magnetic Permeability (μr) = ____________	1+χ	1/χ	1+χ	1+H	1+χ
Those substances which are strongly magnetized in the direction of the external magnetic field are called as ________	paramagnet	anti ferro	diamagnetic	ferromagnetic substances	ferromagnetic substances
Magnetic fields do no interact with ____________.	Moving permanent magnets	Stationary permanent magnets	Moving electric charges	Stationary electric charges	Stationary electric charges
The magnetic permeability of a material is defined as ratio of magnetic induction (B) to ______	susceptibility	magnetic intensity	magnetic field intensity	magnetic field	magnetic intensity
Above Curie temperature, Ferromagnetic substances become _________	magnet	anti ferro	diamagnetic	paramgnetic	paramgnetic
________ is defined as pole strength per unit area of cross section of material	susceptibility	magnetizing field	magnetic field intensity	intensity of magnetization	intensity of magnetization
The Curie Temperature (°K) for Nickel is _________ °K	136	316	613	631	631
The degree or extent to which magnetic field can penetrate or permeate a material is called ___________	magnetic permeability	susceptibility	magntic induction	intensity	magnetic permeability
Total number of magnetic lines of force crossing per unit area normally through a material is called ________	magnetic permeability	susceptibility	magntic induction	intensity	magntic induction
The magnetic energy stored in an inductor is ______ current	Directly proportional to	Inversely proportional to	Directly proportional to the square of	Inversely proportional to the square of	Directly proportional to the square of
The ratio of the permeability of material to the permiabiity of air or vacuum.	Relative permeability	Relative permittivity	Relative conductivity	Relative reluctivity	Relative permeability
The property of magnetic materials of retaining magnetism after withdrawal of the magnetizing force is known as	Retentivity	Reluctivity	Resistivity	Conductivity	Retentivity
The force between two magnetic poles varies with the distance between them. The variation is ______ to the square of that distance.	Equal	Greater than	Directly proportional	Inversely proportional	Inversely proportional
Permeability means	The conductivity of the material for magnetic lines of force	The magnetization test in the material after exciting field has beenremoved	the strength of an electromagnet	The strength of the permanent magnet	The conductivity of the material for magnetic lines of force
The magnetic field inside a solenoid	is constant	is uniform	increases with distance from the axis	decreases with distance from the axis	is uniform
Paramagnetic substance has a relative permeability of	Slightly less than one	Equal to one	Slightly greater than one	Very much greater than one	Slightly greater than one
For which of the following substance, the magnetic susceptibility is independent of temperature____	Dia	Para	Ferro	ferri	Dia
Electromagnets are made of soft iron because soft iron has___	high susceptibility and low retentivity	high susceptibility and high retentivity	low susceptibility and low retentivity	low susceptibility and high retentivity	high susceptibility and low retentivity

Magnetic field is always ____________.	solenoidal	Irrotational	harmonic in character	rotational	solenoidal
Magnetic flux has the dimension __________.	$ML^2T^{-2}I^{-1}$	$MLT^{-2}I^{-1}$	ML^2TI^{-1}	$ML^2T^{-2}I$	$ML^2T^{-2}I^{-1}$
The permeability of free space is _________ WbA-1m-1.	$\mu_0=4\pi$	μ_0=4πx107	$\mu_0=4\pi x10^{-7}$	μ_0=4πx10 -8	$\mu_0=4\pi x10^{-7}$
The intrinsic magnetic moment of the atoms of a material is not zero.The material ______________.	must be paramagnetic	must be diamagnetic	must be ferromagnetic	may be paramagnetic or ferromagnetic	may be paramagnetic or ferromagnetic
The relative permeability of a material is 0.98.The material must be _______________.	paramagnetic	diamagnetic	ferromagnetic	ferrimagnetic	diamagnetic
Hysteresis refers to the ______ between flux density of the material and the magnetizing force applied.	Leading effect	Ratio	Equality	Lagging effect	Lagging effect
Hydrogen is an example of a _____ material.	Paramagnetic	Diamagnetic	Ferromagnetic	Non- magnetic	Paramagnetic
Cobalt is an example of a ______ material	Paramagnetic	Diamagnetic	Ferromagnetic	Non- magnetic	Ferromagnetic
Magnetic intensity is a	Phasor quantity	Physical quantity	Scalar quantity	Vector quantity	Vector quantity
The core of a magnetic equipment uses a magnetic material with	Least permeability	Low permeability	Moderate permeability	High permeability	High permeability
Which of the following is a paramagnetic material?	Carbon	Copper	Bismuth	Oxygen	Oxygen
._______ crystals are frequently used in computers memory cells.	Ferroelectric	Diamagnetic	Paramagnetic	Ferrielectric	Ferroelectric
Platinum exhibits the property of __________.	diamagnet	ferromagnet	paramagnet	none	paramagnet
Diamagnetic substance are attracted by magnetic field.The attraction is _________.	very strong	weak	zero	negative	weak
A moving charge produces __________.	electric field only	magnetic field only	both electric and magnetic fields	neither electric nor magnetic	both electric and magnetic fields
Differential form of Ampere's law for a steady current is _________.	$\Delta xH=J+\partial D/\partial t$	$\Delta xB=\mu_0 J$	Δ.B=0	∫B.dl= μ0I	$\Delta xB=\mu_0 J$
The phenomenon by which a magnetic substance becomes a magnet when it is place near a magnet	Magnetic effect	Magnetic phenomenon	Magnetic induction	Electromagnetic induction	Electromagnetic induction
Which of the following materials has permeability slightly less than that of free space?	Paramagnetic	Non- magnetic	Ferromagnetic	Diamagnetic	Diamagnetic
The property of a material which opposes the creation of magnetic flux in it	Resistance	Reluctance	Permeance	Conductance	Reluctance
The susceptibility of a paramagnetic gas varies ________ as the absolute temperature.	directly	inversely	Similarily	opposite	inversely
If the relative permeability is less than 1,then the material will be_______________.	dia	para	ferro	ferri	dia

If the relative permeability is greater than 1,then the material will be_______________.	dia	para	ferro	ferri	para
If the relative permeability is very much greater than 1,then the material will be_______________.	dia	para	ferro	ferri	ferro
Lenz's law is a consequence of the law of conservation of	energy	momentum	mass	charge	energy
Lenz's law does not violate the principle of	conservation of charge	conservation of energy	conservation of mass conservation of momentum		conservation of energy
The direction of the induced emf during electromagnetic induction is determined by	Lenz's law	Amperes law	Maxwell law	Faaradays law	Lenz's law
Alternative current generator is basically based upon	amperes law	Lenz's law	faradays law	coulombs law	faradays law
Moving a coil in and out of magnetic field induces	force	potential difference	emf	voltage	emf
Which two values are plotted on a B-H curve graph?	reluctance and flux density	permeability and reluctance	magnetizing force and permeability	flux density and magnetizing force	flux density and magnetizing force
Faraday's law states that the:	irection of the induced voltage produces an opposition	emf is related to the direction of the current	emf depends on the rate of cutting flux	direction of an induced current produces an aiding effect	emf depends on the rate of cutting flux
What does Faraday's law concern?	a magnetic field in a coil	a magnetic field cutting a conductor	a magnetic field in a conductor	a magnetic field hystersis	a magnetic field cutting a conductor
What is hysteresis?	lead between voltage and current	lag between cause and effect	lag between voltage and current	lead between cause and effect	lag between cause and effect
What type of device consists of a coil with a moveable iron core?	solenoid	armature	read switch	relay	solenoid

UNIT - III

Einstein's theory of photoelectric effect is based on	Newtons corpuscular theory of light	Huygen's wave theory of light	Maxwell's electromagnetic theory of light	Planck's quantum theory of light	Planck's quantum theory of light
The equation E= hν was deduced by:	Heisenberg	de Broglie	Einstein	Planck	Einstein
De Broglie wavelength (λ) associated with moving particles, mass, m, and velocity v is	h/mv	h/√2mEk	h/√2mqV	h/√2mkT	h/mv
Based on quantum theory of light, the bundles of energy =	hν	hλ	h/ν	h/λ	hν
De Broglie wavelength (λ) associated with moving particles of K.E is	h/mv	h/√2mEk	h/√2mqV	h/√2mkT	h/mv
Wave nature is not observed in daily life because we are using ___________.	Microscopic particles	macroscopic particles	molecules	atoms	macroscopic particles
_______ year de Broglie proposed that the idea of dual nature.	1921	1922	1923	1925	1923
de Broglie wavelength (λ) associated with charge q and potential difference of V volts is	h/mv	h/√2mEk	h/√2mqV	h/√2mkT	h/mv
The photoelectric effect was explained by Albert Einstein by assuming that:	light is a wave.	light is a particle.	an electron behaves as a wave.	an electron behaves as a particle.	light is a particle
The Compton Effect supports which of the following theories?	Special Theory of Relativity.	Light is a wave.	Thomson model of the atom.	Light is a particle.	Light is a particle.
Which one of the following objects, moving at the same speed, has the greatest de Broglie wavelength?	Neutron	Electron	Tennis ball	Bowling ball	electron
Which of the following formulas can be used to determine the de Broglie wavelength?	λ = hmv	λ = h/mv	λ = mv/h	λ = hm/c	λ = h/mv
The idea of dual nature of light was proposed by	Plank	De Broglie	Einstein	Maxwell	De Broglie

According to the de Broglie's hypothesis of matter waves, the concepts of energy, momentum and wavelength are applicable to	moving particles but not to radiation (photon)	moving particles as well as to radiation (photon)	radiation (photon) but not to moving particles	neither to moving particles nor to radiation (photon).	moving particles as well as to radiation (photon)
Experimental verification of de Broglie's matter waves was obtained in	Einstein‟s Photoelectric experiment	Davisson and Germer Experiment	Compton‟s Experiment	Plank	Davisson and Germer Experiment
The first experimental evidence for matter waves was given by _______	Einstein	de Broglie	Plancks	Davisson and Germer	Davisson and Germer
The de Broglie wavelength wave length of a moving electron subjected to a potential V is	1.26/V1/2	12.26/V1/2	12.26/V	2.26/V1/2	12.26/V1/2
Compute the de Broglie wavelength of an electron that has been accelerated through a potential difference of 9.0 kV. Ignore relativists effects.	1.3 x 10-11 m	1.7 x 10^{-22} m	1.2 x 10^{-26} m	1.7 x 10 3 m	1.7 x 10^{-22} m
Heisenberg's uncertainty principle states for the energy and time is	$\Delta E\Delta t = h$	$\Delta E\Delta t = h/2\pi$	$\Delta E\Delta t = 2\pi h$	$\Delta E\Delta t = 2\ \pi\ /h$	$\Delta E\Delta t = h/2\pi$
In which of the following is the radius of the first orbit minimum?	hydrogen atom	A tritium atom	Triply ionized beryllium	Doubly ionized helium	hydrogen atom
The Kinetic energy of electron of mass (m) is given by (T)	p/2m	$p^2/2m$	2mp	$2mp^2$	$p^2/2m$
Heisenberg's uncertainty principle states for the angular momentum and angle is	$\Delta J\Delta\theta = h$	$\Delta J\Delta\theta = h/2\pi$	$\Delta J\Delta\theta = 2\pi h$	$\Delta J\Delta\theta = 2\ \pi\ /h$	$\Delta J\Delta\theta = h/2\pi$
The radius of the nucleus of any atom is of the order of ____ m	10-8 m	10 -14 cm	10-14m	10-10 m	10-14m
Heisenberg's uncertainty principle states for the position and momentum is	$\Delta p\Delta q = h$	$\Delta p\Delta q = h/2\pi$	$\Delta p\Delta q = 2\pi h$	$\Delta p\Delta q = 2\ \pi\ /h$	$\Delta p\Delta q = h/2\pi$
The uncertainty in the total energy (ΔE) is	$\Delta T + \Delta V$	$\Delta T - \Delta V$	ΔT	ΔV	$\Delta T + \Delta V$
Based on the uncertainty principle, the minimum momentum (Pmin) =	ħ/I	ħ	ħl	l/ ħ	ħ
Who proposed the uncertainty principle?	Bohr	De Broglie	Heisenberg	Schroedinger	Heisenberg
The kinetic energy of electron in the atoms is	4 Mev	6 Mev	8 MeV	97 Mev	97 Mev
According to Heisenberg‟s Uncertainty principle, Indeterminism in the measurement of canonically conjugate variables is due to	imperfection in measuring instruments	imperfection in measurement methods	the interminisim inherent in the auantum world itself		imperfection in measuring instruments
The value of ħ is	6.625 x 10^{-34} nm	5 x 10^{-34} nm	1.055 x 10^{34}nm	1.0555 x 10^{-34} nm	1.055 x 10^{34}nm
The mass of an electron is	9 x 10^{-34} nm	9x 10^{-31} m	6 x 10^{-34} nm	6.625 x 10^{-30} nm	9x 10^{-31} m
If we measure the position of a particle accurately then the uncertainty in measurement of momentum at the same instant becomes	0	Infinity	1	constant	Infinity
If we measure the energy of a particle accurately then the uncertainty in measurement of the time becomes	0	Infinity	1	constant	Infinity
Uncertainty principle is applicable to	macroscopic particles	microscopic particles	gases	liquids	microscopic particles
Uncertainty principle can be easily understandable with help of	Dalton's effect	Compton's effect	electron effect	photoelectric effect	Compton's effect
Heisenberg gave his concept in	1923	1927	1957	1933	1927
Heisenberg uncertainty principle is used for	data processing	information processing	data processinerosion	dilation	information processing
The Heisenberg uncertainty principle is concerned with what two properties?	mass and velocity	momentum and position	position and velocity	momentum and mass	momentum and position
Energy of photon is directly related to the	wavelength	wave number	frequency	amplitude	frequency
____ forms of Schroedinger's equation describe the motion of non-relativistic material particle.	$H\psi = E\psi$	$H\psi \neq E\psi$	$H\psi < E\psi$	$H\psi > E\psi$	$H\psi = E\psi$
If ψ_1 and ψ_2 are two different wave functions, both being satisfactory solution of wave equation for a given system, then these functions will be normalized, if	$\psi_j{}^*\psi_j d\tau = 1$	$\psi_j{}^*\psi_j d\tau \neq 1$	$\psi_j{}^*\psi_j d\tau > 1$	$\psi_j{}^*\psi_j d\tau < 1$	$\psi_j{}^*\psi_j d\tau = 1$
Schrodinger suggested seeking solutions of the waves equation which represents ___ waves.	non-progressive	progressive	non-standing	standing	standing
Momentum operator in Schroedinger equation (Pop) is	ħ/i	ħi	i/ħ	Ħ	ħ/i
The minimum energy of a particle in a box (E) is	$\hbar^2/ml^2$	$\hbar^2/2ml^2$	$ml^2/\hbar^2$	$2ml^2/\hbar^2$	$\hbar^2/2ml^2$
The Schroedinger time-dependent wave equation is	$H\psi = E\psi$	$H\psi \neq E\psi$	$H\psi < E\psi$	$H\psi > E\psi$	$H\psi = E\psi$
The time-dependent Schroedinger equation is partial differential equation having ___ variables.	1	2	3	4	3
The Schroedinger equation for a free particle is	$\Delta^2\psi + (2m/\hbar^2)(E)\psi = 0$	$\Delta^2\psi + (2m/\hbar^2)(E)\psi \neq 0$	$\Delta^2\psi + (2m/\hbar^2)(E)\psi < 0$	$\Delta^2\psi + (2m/\hbar^2)(E)\psi > 0$	$\Delta^2\psi + (2m/\hbar^2)(E)\psi = 0$
The time independent form of Eop is	H	V	U	T	H
Wave function Ψ of a particle is	real quantity	a complex quantity	an imaginary quantity	any one of these	real quantity
Wave function is represented by ________	ψ	E	H	W	ψ
Schroedinger attempt the physical interpretation of ψ in terms of _______	volume density	current density	density	charge density	charge density
In wave function, energy per unit volume is equal to ___	A^2	E^2	H2	ψ^2	A^2
Photon density is ____	hν	A^2/h	A^2/ν	$A^2/h\nu$	$A^2/h\nu$
Photon density is proportional to ______	hν	A^2	h	ν	A^2
Particle density is proportional to ______	hν	ψ^2	h	ν	ψ^2
Schrodinger's equation described the	wave function	complement of the wave function	behavior of "matter" waves	motion of light	behavior of "matter" waves

Solutions to Schrodinger's equation are labeled with	psi	phi	mu	pi	psi
The hypothesis that nuclear forces possess an exchange character was put forward by	Pauli	Rutherford	Heisenberg	Max Plank	Heisenberg
Heisenberg force is due to	exchange of space	exchange of spin	exchange of space a	exchange of momen	exchange of space a
UNIT - IV					
The potential involved outside the nucleus is ____	gravitational	electromagnetic	nuclear	Coulombic	Coulombic
The atomic mass is almost equal to _____	the mass of the electron	the mass of the nucleus	the mass of the protons	the mass of the neutrons	the mass of the nucleus
The nuclear radius is proportional to	A^2/3	A	A^1/3	A^2	A^1/3
The nucleon density at the centre of any nucleus is	proportional to A	proportional A^2	proportional Z	almost the same	almost the same
The force which holds the nucleons together in a nucleus is	elelctromagnetic force	gravitational force	strong nuclear force	weak interaction	strong nuclear force
The non-central part of the nuclear force is called	elelctromagnetic force	tensor force	magnetic force	static force	tensor force
Nuclear exchange forces arise due to	exchange of mesons	exchange of charge	exchange moments	exxchange of strangeness	exchange of mesons
Nucleus is	positively charged	negatively charged	neutral	charge keeps on changing	positively charged
Proton has the charge	1637 times of an electron	1737 times of an electron	1837 times of an electron	1937 times of an electron	1837 times of an electron
Neutrons has the charge	1639 times of an electron	1739 times of an electron	1839 times of an electron	1939 times of an electron	1839 times of an electron
The difference between the total mass of the individual nucleons and the mass of the nucleus is known as	mass defect	binding energy	packing fraction	mass excess	mass defect
The mass of the nucleus is normally -------- the total mass of the nucleons	greater than	equal to	less than	can be anything	less than
Instrument used to measure nuclear masses and their other properties is called	Mass spectrograph	nuclear spectrometer	NMR spectrometer	magnetic spectrometer	Mass spectrograph
The constant nucleon density inside the nucleus supports	liquid drop model of the nucleus	shell model	collective model	unified model	liquid drop model of the nucleus
The constant binding energy per nucleon supports	shell model	collective model	liquid drop model	unified model	liquid drop model
In the liquid drop model, the restoring force after deformation is supplied by	internal force	gravitational attraction	surface tension	repulsion	surface tension
The surface energy is proportional to ---- where A is the mass number	A	A^1/3	A^2/3	A^2	A^2/3
The liquid drop model could not explain satisfactorily ----	surface vibration of the nuclei	surface energy of the nuclei	all the above	low lying discrete energy levels of nuclei	low lying discrete energy levels of nuclei
According to alpha particle model, a nucleus can be considered as	a sphere of individual nucleons	poly-atomic molecule of alpha particles	alpha and beta particles	poly-atomic molecule of beta particles	poly-atomic molecule of alpha particles
Alpha particle model could not describe the ground and excited states of	nuclei other than even-even nuclides	even-even nuclides	even-odd nuclides	odd-even nuclides	nuclei other than even-even nuclides
It is seen that nuclei with ----- nucleons are most stable, where n=1,2,3,….	2n-1	4n-2	4n	2n	4n
The nuclei with Z = ----- and ------ are found to be more than usually stable	50, 20	50,40	20, 40	30, 40	50, 20
The resemblance of the nucleus with a drop of liquid led to the suggestion of ----- model.	Fermi gas model	collective model	liquid drop model	Shell model	liquid drop model
The nuclear fission can be best explained using	shell model	liquid drop model	Fermi gas model	collective model	liquid drop model
As per liquid drop model, if the energy of the incident neutron is less than the critical energy, ----- takes place.	radiative capture	fusion	gamma ray emission	fission	radiative capture
Which model is the combination of liquid drop and shell model	Collective model	Unified model	optical model	Super-conductivity model	Collective model
Nuclei with N or Z near the end of a shell are found in …………. Distinct groups, known as islands of isomerism	three	two	seven	four	four
Alpha particle is emitted from	outside the nucleus	inside the nucleus	from the external orbits	inside a proton	inside the nucleus
The spin of an alpha particle is	1	1-Feb	3-Feb	0	0
Alpha particle is of ----- parity	no parity	odd	even	odd or even	even
The penetrating power of alpha particle is	large	small	medium	zero	small
There are ---- types of beta emission	2	1	3	4	3
The spin of the beta particle is	1-Feb	3-Feb	1	0	1-Feb
What is the most penetrating radiation?	gamma	alpha	beta	positron	gamma
Which types of radiation is the most dangerous?	gamma	alpha	beta	they are equally dangerous	gamma
A particle striking on the target nucleus, is absorbed by it and a new particl	photo disintegration	radiative capture	elastic scattering	disintegration	disintegration
Emission of alpha and beta rays is an example of	photo disintegration	radiative capture	spontaneous decay	spallation reaction	spontaneous decay
The strong nuclear force is	charge dependent	both charge and size	charge indendent	size dependent	charge indendent

UNIT-V

Which number system is not a positional notation system?	ROMAN	Binary	decimal	Hexadecimal	ROMAN
The 10's complement of the octal number 715 is	63	539	285	395	539
The 9's complement of 381 is	372	508	618	390	618
The 1's complement of the binary number 1101101 is	10	100010	10011	1101110	100010
The 2's complement of the binary number 010111.1100 is	101001.11	101000.01	10111.0011	101000.0011	101000.01
Which system has a base or radix of 10:	Binary digit	Hexadecimal digit	Decimal digit	Octal digit	Decimal digit
In which counting, single digit are used for none and one:	Decimal counting	Octal counting	Hexadecimal counti	Binary counting	Binary counting
In which numeral every position has a value 2 times the value f the positic	Decimal	Octal	Hexadecimal	Binary	Binary
In which digit the value increases in power of two starting with 0 to left of t	Hexadecimal	Decimal	Binary	Octal	Binary
Which system is used in digital computers because all electrical and electro	Hexadecimal numbe	Binary number	Octal number	Decimal number	Binary number
Which number is formed from a binary number by grouping bits in groups c	Binary	Octal	Decimal	Hexadecimal	Hexadecimal
Which number system has a base of 16 :	Binary number syst	Octal number syster	Decimal number sy	Hexadecimal numbe	Hexadecimal numbe
. Counting in hex, each digit can be increment from__________:	0 to F	0 to G	0 to H	0 to J	0 to F
Which number can be converted into binary numbers by converted each he	Binary number	Decimal number	Octal number	Hexadecimal numbe	Hexadecimal numbe
. How many system of arithmetic, which are often used in digital syster	5	6	3	4	4
Which are the system of arithmetic, which are often used in digital system:	Binary digit	Decimal digit	Hexadecimal digit	All of these	All of these
A number system that uses only two digits, 0 and 1 is called the_________	Octal number syster	Binary number syst	Decimal number sy	Hexadecimal numbe	Decimal number sys
Which of the following gates is known as coincidence detector?	AND	OR	NOT	NAND	AND
An inverter is also called as	NOT	OR	AND	NAND	NOT
Which gate has two or more input signals in which all input must be high tc	OR	NAND	AND	NOR	AND
A NOR gate has a high output only when the input bits are	low	high	some low some higl	None of the above	low
A NOR gate is logically equivalent to an OR gate followed by an	AND	NAND	XOR	INVERTER	INVERTER
Boolean expression for NOR gate with two inputs x and y can be written as	(x+y)'	x . y	x+y	xy' + x'y	(x+y)'
Boolean expression for NAND gate with two inputs x and y can be written	xy	x+y	x'+y'	None of the above	x+y
NAND gates can be used as which type gates?	NOT	OR	AND	All of the above	All of the above
An OR gate can be imagined as	switches connected	switches connected	MOS transistors co	None of the above	switches connected
Which gate is known as Universal gate?	NOT	AND	NAND	OR	NAND
Any Boolean expression can be implemented using	only NOR gates	only NAND gates	only AND gates	only XOR gates	only NAND gates
Which digits are used to represent high & low level in digital circuits?	1 0	0 1	0 0	1 1	1 0
Complement of a Variable is represented by _________ over the Letter.	slash	bar	dot	hyphen	bar
What is the value for 1+1 in Boolean Addition?	2	10	1	0	1
Multiplication in Boolean algebra is the same as the __________ function	AND	OR	NOT	NOR	AND
The operation of an inverter is________	Complement Input	add +1 to input vari	add –1 to input vari	minus input variabl	Complement Input v
___________is same as Inversion.	complementation	exclusive	AND	OR	complementation
The output of an AND gate is 1(High) only when both inputs are ________	1 0	0 0	1 1	0 1	1 1
The output of an OR gate is 1(High) only when any one or more of the inpu	high	low	medium	high	high
NAND is a complement of __________	NOT	AND	OR	NOR	AND
NOR is a complement of __________	NOT	AND	OR	NAND	OR
Commutative Law of Addition of 2 variables is written as	A+B=B+A	B+A=B+A	A+B=A + B	AB=AB	A+B=B+A
Commutative Law of Multiplication of 2 variables is written as	AB=BA	BA=BA	AB=AB	AB=A+B	AB=BA
Associative law of addition is stated as	A + (B + C) = (A+E	(A + B)+ C = (A+B	(A+B) C = A (B+C	AB+C = A+BC	A + (B + C) = (A+E
Associative law of multiplication is stated as	A (BC)=(AB) C	ABC=ACB	AB = BA	ABC=CAB	A (BC)=(AB) C
Distributive Law is stated as	A (B+C) = AB + AC	AB + AC = ABC	AB + C= AC + B	(AB) + C = AB + A	A (B+C) = AB + AC
In Boolean algebra A + 0 =?	A	0	–A	1	A
In Boolean algebra A + 1 =?	A	0	–A	1	1
In Boolean algebra A .0 =?	A	0	–A	1	0
In Boolean algebra A .1 =?	A	0	–A	1	A
In Boolean algebra A +A =?	A	0	–A	1	A
In Boolean algebra A + Ā =?	A	0	–A	1	1
In Boolean algebra A .A =?	A	0	–A	1	A
In Boolean algebra A. Ā =?	A	0	–A	1	0
In Boolean algebra A + AB =?	A	0	–A	1	A
In Boolean algebra A + ĀB =?	A	0	B	A + B	A + B
In Boolean algebra (A +B)(A + C) =?	A	0	B	A +BC	A +BC
The Complement of a Sum =	Sum of the Comple	Product of the Com	Complement of the	Sum	Sum of the Comple
Sum of Product expression is	two or more AND f	two or more OR fur	two or more AND f	two or more OR fur	two or more AND fu
Product of Sum expression is	AND of two or mo	OR of two or more	AND of two or mo	OR of two or more	AND of two or mo
Boolean expression can be simplified using	Associative law	rules and laws of Bo	Distributive law	None of the above	rules and laws of Bo
Sum of products expression is implemented with ________	AND-OR logic	OR-AND logic	NAND logic	NOR logic	AND-OR logic
The output of an exclusive – OR gate is HIGH when inputs have	Same state	Opposite State	Complement State	Alternate State	Opposite State
The output of an exclusive – NOR gate is HIGH when inputs have	Same state	Opposite State	Complement State	Alternate State	Same state
Any Logic Expression can be implemented using	NAND / NOR	AND / OR	X-OR / OR	NAND / AND	NAND / NOR
What are the common internal gate failures?	open input or outpu	open input or outpu	open input or outpu	open input or outpu	open input or output
The interconnecting paths represent a common electrical point is known as	Cell	Node	Point	Junction	Junction
The coincidence circuit is otherwise called as	Exclusive-NOR	Exclusive – OR	Exclusive – AND	Exclusive – NAND	Exclusive – OR
NAND & NOR gates are called as	Universal Gates	Functional gates	Logical Gates	Combinational gate	Universal Gates
Sum of products can be done using	demorgan's theorem	algebric theorem	demorgan's postulat	algebric postulate	demorgan's theorem
Two variables will be represented by	eight minterms	six minterms	five minterms	four minterms	four minterms
The output of AND gates in SOP is connected to	NOT gates	OR gates	AND gates	XOR gates	OR gates
The minterms in a karnaugh map are marked with a	y	x	0	1	1
Small circle in a NAND circuit represents	input	bits	output	complement	complement
Tabulation method is adopted for giving simplified function in	subtraction of sum	sum of products	product of sums	subtraction of produ	product of sums
Each square in a karnaugh map represents a	points	values	minterm	maxterm	minterm
Sum of products can be done using	demorgan's theorem	algebric theorem	demorgan's postulat	algebric postulate	demorgan's theorem