Digital Electronics

Q. RECTIFIERS

A rectifier is a device that converts an oscillating two-directional alternating current (AC) into a single-directional direct current (DC). Rectifiers can take a wide variety of physical forms, from vacuum tube diodes and crystal radio receivers to modern silicon-based designs.

●FULLWAVE RECIFERS.

A full wave rectifier is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC.

When used in a power supply, the full-wave rectifier allows us to convert almost all the incoming AC power to DC. The full-wave rectifier is also the heart of the circuitry that allows sensors to attach to the RCX in either polarity.

The full wave rectifier is further classified into two types: center tapped full wave rectifier and full wave bridge rectifier.

The main difference between bridge rectifier and center tapped full wave rectifier is that, bridge rectifier produces almost double the output voltage using the same secondary voltage. Center tapped rectifier as the name suggests requires a center tapped transformer (secondary winding).

● HALFWAVE RECTIFIERS.

A half-wave rectifier converts an AC signal to DC by passing either the negative or positive half-cycle of the waveform and blocking the other. Half-wave rectifiers can be easily constructed using only one diode, but are less efficient than full-wave rectifiers.

A half-wave rectifier is used in soldering iron types of circuit and is also used in mosquito repellent to drive the lead for the fumes. In electric welding, bridge rectifier circuits are used to supply steady and polarized DC voltage.

●Advantages of half-wave rectifier:

•Half wave rectifier is a simple circuit.
•It has a low cost.
•We can easy to use it.
•We can easily construct.
•It has a low number of component, therefore it is cheap.

●Disadvantages of half-wave rectifier:

•The transformer utilization factor is low.
•They produce a low output voltage.

DC saturation of transformer core resulting in magnetizing current and also some hysteresis losses and generation of harmonics.

•The power output and therefore rectification efficiency are quite low. This is due to the fact that power is delivered only during the one-half cycle of the input alternating voltage.
•Ripple factor is high and elaborate filtering is, therefore required to give steady dc output.

●Advantages of full-wave rectifier:

•The ripple frequency is two times the input frequency.
•Efficiency is higher.
•The large DC power output.
•Ripple factor is less.

The ripple voltage is low and the higher frequency in case full-wave rectifier so simple filtering circuit is required.

•Higher output voltage.

●Disadvantages of full-wave rectifier:

•More complected than half-wave rectifier.
•It requires more diodes, two for center tap rectifier and four for bridge rectifier.
•PIV rating of the diode is higher.
•Higher PIV diodes are larger in size and too much costlier.
•The cost of the center tap transformer is high.

Q. ZENER DIODE

Zener diode is a special type of diode designed to reliably allow current to flow "backwards" when a certain set reverse voltage, known as the Zener voltage, is reached. Zener diodes are manufactured with a great variety of Zener voltages and some are even variable. Zener diodes are used for voltage regulation, as reference elements, surge suppressors, and in switching applications and clipper circuits. The load voltage equals breakdown voltage VZ of the diode.

- Advantages of Zener diode:

•The Zener diode is less expensive than another diode
•This diode can be used in regulate and stabilize the voltage in a circuit
•These diodes have a high-performance standard
Control the flowing current
•Compatibility and obtainability

- Disadvantages of Zener diode:

•Zener diode cancels out voltage by applying an even larger voltage in the reverse direction wasting electricity in the process.
•A Zener diode has a relatively poor regulation ratio and is generally not as good as the transistor.

- Zener diode as a voltage regulator.

The Zener diode is often in use as a voltage regulator, primarily because the voltage drop across the diode is constant. Furthermore, the supply voltage must exceed the Zener voltage for the circuit to operate. Thereby, any electronic component connected in parallel with these diodes will have the same applied voltage.Zener Diodes are widely used as Shunt Voltage Regulators to regulate the voltage across small loads. Zener Diodes have a sharp reverse breakdown voltage and breakdown voltage will be constant for a wide range of currents.
☆A Zener diode operates just like a normal diode when it is forward-biased. However, a small leakage current flows through the diode when connected in reverse biased mode. As the reverse voltage increases to the predetermined breakdown voltage (Vz), current starts flowing through the diode.

Q. BYIPOLAR JUNCTION TRANSITOR

A transistor is a semiconductor device used to amplify or switch electrical signals and power. The transistor is one of the basic building blocks of modern electronics. It is composed of semiconductor material, usually with at least three terminals for connection to an electronic circuit.
A bipolar junction transistor (BJT) is a type of transistor that uses both electrons and electron holes as charge carriers. In contrast, a unipolar transistor, such as a field-effect transistor, uses only one kind of charge carrier. A bipolar transistor allows a small current injected at one of its terminals to control a much larger current flowing between the terminals, making the device capable of amplification or switching.A bipolar junction transistor is a three-terminal semiconductor device that consists of two p-n junctions which are able to amplify or magnify a signal. It is a current controlled device. The three terminals of the BJT are the base, the collector, and the emitter.BJTs exist as PNP and NPN types, based on the doping types of the

three main terminal regions. An NPN transistor comprises two semiconductor junctions that share a thin p-doped region, and a PNP transistor comprises two semiconductor junctions that share a thin n-doped region.

Advantages of BJT :
▪They have a better voltage gain
▪They have a high current density
▪They have a low forward voltage
▪It can be operated in low to high power application
▪BJT has a large gain bandwidth
Disadvantages of BJT :
▪BJT has a low thermal stability
▪BJT is most effective by radiation
▪BJT has more noise produced
▪BJT has a low switching frequency
▪BJT has a very complex control.

Any transistor circuit can be designed using three types of configuration. Three configurations of the transistor are based on the connection of the transistor terminal.Configuration Of Transistor
Common Emitter Transistor.
Common Base Transistor.
Common Collector Transistor(emitter follower).

Q. RC phase shift oscillator

An RC phase shift oscillator is one of many AC oscillator circuits that is adaptable to a wide range of loads. This circuit outputs a clean sine wave with scalable frequency by applying feedback through successive RC networks.It consists of an inverting amplifier element such as a transistor or op amp with its output fed back to its input through a phase-shift network consisting of resistors and capacitors in a ladder network.
The RC phase shift oscillator gives good Frequency stability. The output of this circuit is sinusoidal that is quite distortion free.. It is suitable for lower frequencies and this lower limit exists in as low as 1 Hz. RC phase shift oscillators don't require any negative feedback and stabilization arrangements.
RC oscillators are used in low-frequency applications. The applications of these oscillators mainly include voice synthesis, musical instruments, & GPS units as they perform at all audio frequencies.

Q. MULTI VIBRATOR (ASTABLE MULTIVIBRATOR).

Multivibrator is an electronic circuit which will work as two stage amplifier operating in both stable and astable mode.In the multivibrator the output of first stage is given to the second stage and the second stage output is again feed back to the first stage by this the cutoff state will become saturate and saturate state will become to cutoff. Because of the transition of states the multivibrator can be used as oscillators, timers and flip-flops.
A multivibrator circuit is nothing but a switching circuit. It generates non-sinusoidal waves such as Square waves, Rectangular waves and Saw tooth waves etc. Multivibrators are used as frequency generators, frequency dividers and generators of time delays and also as memory elements in computers

Astable Multivibrator:
This multivibrator will not be stable in both the states; it will rapidly get switches from one state to another state. This type of multivibrator is mainly used as oscillators. Astable multivibrator is also called as free running multi vibrators there is no limit or time for switching the states. Astable multivibrator, in which the circuit is not stable in either state —it continually switches from one state to the other. It functions as a relaxation oscillator.

Q.DeMorgan's theorems.
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 will be a negative-OR function, proving that A.B = A+B.
The second theorem states that the complement of the product of two inputs is equal to the sum of its complements.

Q.SOP expressions.
the Sum-of-Products (SOP) expression is a standard boolean expression that "Sums" two or more "Products" and that for a digital logic circuit an SOP expression takes the output of two or more logic AND gates and OR's them together to create the final (AND-OR) output.

Q.POS EXPRESSION
the Product-of-Sum (POS) expression is a standard boolean expression that takes the "Product" of two or more "Sums". For a digital logic circuit the POS expression takes the output of two or more logic OR gates and AND's them together to create the final OR-AND logic output.

Q. FLIP FLOPS
A Flip Flop is an electronic circuit with two stable states that can be used to store binary data. The stored data can be changed by applying varying inputs. Flip-flops and latches are fundamental building blocks of digital electronics systems used in computers, communications, and many other types of systems.Flip-flop is a circuit that maintains a state until directed by input to change the state. A basic flip-flop can be constructed using four-NAND or four-NOR gates. Types of flip-flops: RS Flip Flop. JK Flip Flop.
There are basically four different types of flip flops and these are:
Set-Reset (SR) flip-flop or Latch.
JK flip-flop.
D (Data or Delay) flip-flop.
T (Toggle) flip-flop.

Q. Kmap
A Karnaugh map (K-map) is a pictorial method used to minimize Boolean expressions without having to use Boolean algebra theorems and equation manipulations. A K-map can be thought of as a special version of a truth table . Using a K-map, expressions with two to four variables are easily minimized.Karnaugh maps are used to facilitate the simplification of Boolean algebra functions. For example, consider the Boolean function described by the following truth table.
The K-map simplification technique is simpler and less error-prone compared to the method of solving the logical expressions using Boolean laws.
It prevents the need to remember each and every Boolean algebraic theorem.

Q. ADDERS

A Binary Adder is a digital circuit that implements the arithmetic sum of two binary numbers supported with any length is known as a binary adder. It is generated using full-adder circuits connected in sequence. The output carries from one full-adder linked to the input carry of the next full-adder.
Or
An adder is a device that will add together two bits and give the result as the output. The bits being added together are called the "addends". Adders can be concatenated in order to add together two binary numbers of an arbitrary length. There are two kinds of adders - half adders and full adders.
There are two main types of adders: the half adder and the full adder

Full ADDER:

Full Adder is the adder that adds three inputs and produces two outputs. The first two inputs are A and B and the third input is an input carry as C-IN. The output carry is designated as C-OUT and the normal output is designated as S which is SUM. A full adder logic is designed in such a manner that can take eight inputs together to create a byte-wide adder and cascade the carry bit from one adder to another. we use a full adder because when a carry-in bit is available, another 1-bit adder must be used since a 1-bit half-adder does not take a carry-in bit. A 1-bit full adder adds three operands and generates 2-bit results.

Half Adder (HA):

Half adder is the simplest of all adder circuits. Half adder is a combinational arithmetic circuit that adds two numbers and produces a sum bit (s) and carry bit (c) both as output. The addition of 2 bits is done using a combination circuit called a Half adder. The input variables are augend and addend bits and output variables are sum & carry bits. A and B are the two input bits.
let us consider two input bits A and B, then sum bit (s) is the X-OR of A and B. it is evident from the function of a half adder that it requires one X-OR gate and one AND gate for its construction.

Q.SUBTRACTOR

Full Subtractor:

A full subtractor is a combinational circuit that performs subtraction of two bits, one is minuend and other is subtrahend, taking into account borrow of the previous adjacent lower minuend bit. This circuit has three inputs and two outputs. The three inputs A, B and Bin, denote the minuend, subtrahend, and previous borrow, respectively. The two outputs, D and Bout represent the difference and output borrow, respectively.

Half Subtractor in Digital Logic:

Half Subtractor (HS): Half subtractor is a combination circuit with two inputs and two outputs which is difference and borrow. It produces the difference between the two binary bits at the input and also produces an output (Borrow) to indicate if a 1 has been borrowed. In the subtraction (A-B), A is called a Minuend bit and B is called as Subtrahend bit.

Q. MUX: MULTIPLEXER

A multiplexer (MUX) is a device that can receive multiple input signals and synthesize a single output signal in a recoverable manner for each input signal. It is also an integrated system that usually contains a certain number of data inputs and a single output.
A multiplexer makes it possible for several input signals to share one device or resource, for

example, one analog-to-digital converter or one communications transmission medium, instead of having one device per input signal. Multiplexers can also be used to implement Boolean functions of multiple variables.

In general, to implement B : 1 MUX using A : 1 MUX , one formula is used to implement the same. KN-1 / A = KN = 1 (till we obtain 1 count of MUX). And then add all the numbers of MUXes = K1 + K2 + K3 + …. + KN.

●The advantage of multiplexing is that we can transmit a large number of signals to a single medium. This channel can be a physical medium like a coaxial, metallic conductor or a wireless link and will have to handle multiple signals at a time. Thus the cost of transmission can be reduced.

Q. Demux : Demultiplexer

De-Multiplexer is a combinational circuit that performs the reverse operation of Multiplexer. It has single input, 'n' selection lines and maximum of 2n outputs. The input will be connected to one of these outputs based on the values of selection lines.

A demultiplexer (also known as a demux or data distributor) is defined as a circuit that can distribute or deliver multiple outputs from a single input. A demultiplexer can perform as a single input with many output switches.

Q. Shift Registers in Digital Logic:

Flip flops can be used to store a single bit of binary data (1or 0). However, in order to store multiple bits of data, we need multiple flip flops. N flip flops are to be connected in an order to store n bits of data. A Register is a device which is used to store such information. It is a group of flip flops connected in series used to store multiple bits of data.

The information stored within these registers can be transferred with the help of shift registers. Shift Register is a group of flip flops used to store multiple bits of data. The bits stored in such registers can be made to move within the registers and in/out of the registers by applying clock pulses. An n-bit shift register can be formed by connecting n flip-flops where each flip flop stores a single bit of data.

Q. COMPARATOR

A comparator is an electronic component that compares two input voltages. Comparators are closely related to operational amplifiers, but a comparator is designed to operate with positive feedback and with its output saturated at one power rail or the other.

Comparators are used in central processing units (CPUs) and microcontrollers (MCUs). These are used in control applications in which the binary numbers representing physical variables such as temperature, position, etc. are compared with a reference value.A comparator consists of a specialized high-gain differential amplifier. They are commonly used in devices that measure and digitize analog signals, such as analog-to-digital converters (ADCs), as well as relaxation oscillators.

Comparators are used in central processing units (CPUs) and microcontrollers (MCUs). Examples of digital comparator include the CMOS 4063 and 4585 and the TTL 7485 and 74682.

Note: An XNOR gate is a basic comparator, because its output is "1" only if its two input bits are equal.

Q. Explain D and T flip flops.

D Flip-Flop: When the clock rises from 0 to 1, the value remembered by the flip-flop becomes the value of the D input (Data) at that instant. T Flip-Flop: When the clock rises from 0 to 1, the value remembered by the flip-flop either toggles or remains the same depending on whether the T input (Toggle) is 1 or 0.