Model Question Paper - I with effect from 2021 (CBCS Scheme)

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First/Second Semester B.E Degree Examination

Basic Electronics & Communication Engineering

TIME: 03 Hours **Max. Marks: 100**

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**

Module-1 (Power Supplies, Amplifiers, Operational amplifiers, Oscillators)			**Marks**
Q.01	a	With neat block diagram explain the working of a DC power supply. Also mention the principal components used in each block.	7
	b	Mention advantages of negative feedback in amplifiers circuits. With relevant equations and diagram explain the concept of negative feedback.	7
	c	With circuit diagram and waveform show how operational amplifier can work as a comparator.	6
OR			
Q.02	a	With neat circuit diagram and waveforms explain the working of bridge rectifier.	8
	b	Write a note on frequency response characteristics of an amplifier circuit, clearly mentioning the half power frequencies.	6
	c	List and explain conditions for sustained oscillations. Determine the frequency of oscillation of a three-stage ladder network in which C=10 ηF and R=10 kΩ.	6
Module-2 (Logic Circuits, Data representation, Shift registers, Counters)			
Q. 03	a	Discuss the design of a 3-bit asynchronous up-counter.	6
	b	With a neat block diagram show how typical input and output blocks are connected to a microcontroller unit.	7
	c	With the help of a timing diagram explain how D-type bistable circuit works.	7
OR			
Q.04	a	Design a full adder using two half adders and an OR-gate.	8
	b	Design a 4-stage shift register using J-K bistables.	7
	c	Write a note on different data types mentioning the bit size and range of values supported.	5
Module-3 (Embedded Systems, Sensors and Interfacing, Actuators, Communication Interface)			
Q. 05	a	Explain the working, principle of operation and applications of stepper motor.	8
	b	Write a note on classification of embedded systems.	6
	c	Bring out the main features of UART and USB.	6

		OR	
Q. 06	a	Give the classification of transducers with examples.	6
	b	Bring out the differences between RISC and CISC, Harvard & Von-Neumann.	6
	c	Define 'Actuator' and briefly describe the following actuators - relay, Piezo-buzzer	8
		Module-4 (Analog and Digital Communication)	
Q. 07	a	Describe the blocks of the basic communication system.	6
	b	Define the following terms: (i) Modulation (ii) Carrier communication system (iii) Baseband communication system with neat and suitable waveforms.	6
	c	Explain the following with the help of waveforms. (i) PAM (ii)PWM (iii)PPM (iv) PCM	8
		OR	
Q. 08	a	Define sampling theorem and explain when aliasing can happen. Also mention the different ways in which aliasing can be avoided.	6
	b	Define the following terms: Multipath, Constructive and destructive interference, Coherence time, Coherence bandwidth, Delay spread	10
	c	Define an antenna and discuss different types of antennas.	4
		Module-5 (Cellular Wireless Networks, Wireless Network Topologies, Satellite Communication, Optical Fiber Communication, Microwave Communication)	
Q. 09	a	Draw the schematic diagram of a cellular telephone system and define its basic components.	6
	b	Explain the optical fiber communication system with a block diagram.	6
	c	With the help of diagrams, discuss the following types of network topologies: Ad-Hoc Network Topology, Infrastructure Network Topology	8
		OR	
Q. 10	a	With the help of architecture figures explain the evolution from GSM to LTE.	8
	b	List the requirements identified for the 4G technology.	4
	c	Draw the block diagram showing the basic elements of a satellite communication system and briefly explain them.	8

Solution for VTU Model Question paper Set-1

BASIC ELECTRONICS & COMMUNICATION ENGINEERING (21ELN14)

Module -1

1.a) With neat block diagram explain the working of a DC power supply. Also mention the principal components used in each block (7Marks)

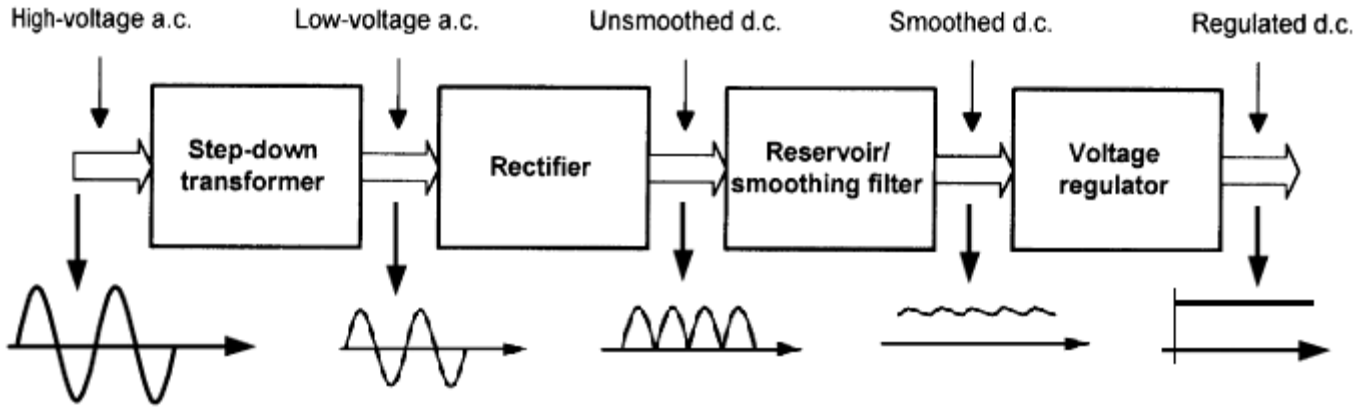
Most of the electronic devices and circuits are operated by DC power supplies. It consist of main four stages explained below.

Step down transformer: It is a device that has two coil windings: primary and secondary used to convert a high AC voltage (230V/ 50Hz) to a required low AC voltage.

Rectifier: It is a device has one or more diodes, converts secondary AC voltage to pulsating DC.

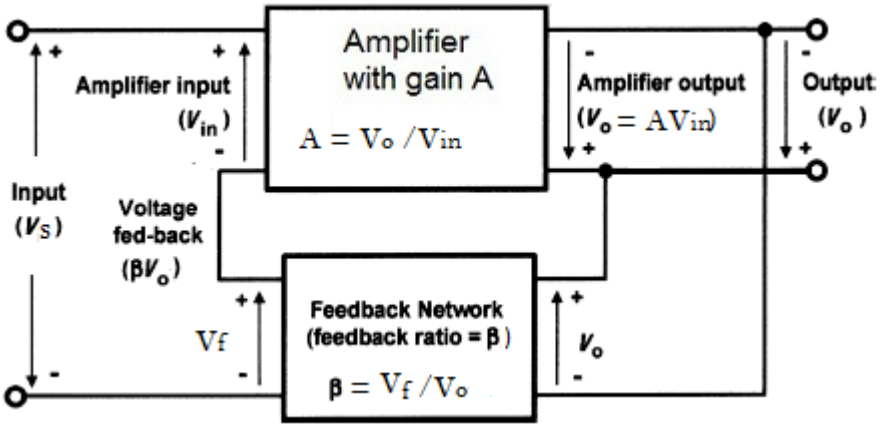
Smoothening Filter: It is a circuit used to remove fluctuations (ripple or ac) present in rectifier output.
Example: Capacitor filters, LC filters, π- filters, etc..

Voltage Regulator: Voltage regulator is a circuit which provides constant DC output voltage irrespective of changes in load current or changes in input voltage.



1. b) Mention advantages of negative feedback in amplifiers circuits. With relevant equations and diagram explain the concept of negative feedback (7 marks)

Advantages of negative feedback system:
precisely control the gain,
reduce distortion and
improve bandwidth, input and output impedances.



$A = Vo/V_{in}$

$Vo = A\,V_{in}$, where $V_{in} = V_S - V_f$, $V_f = \beta Vo$

$Vo = A(Vs - \beta Vo)$

$Vo = AVs - A\,\beta Vo$

$Vo + A\,\beta Vo = AVs$

$AVs = Vo\,(1 + A\beta)$

So, the equation of overall gain with negative feedback is given by

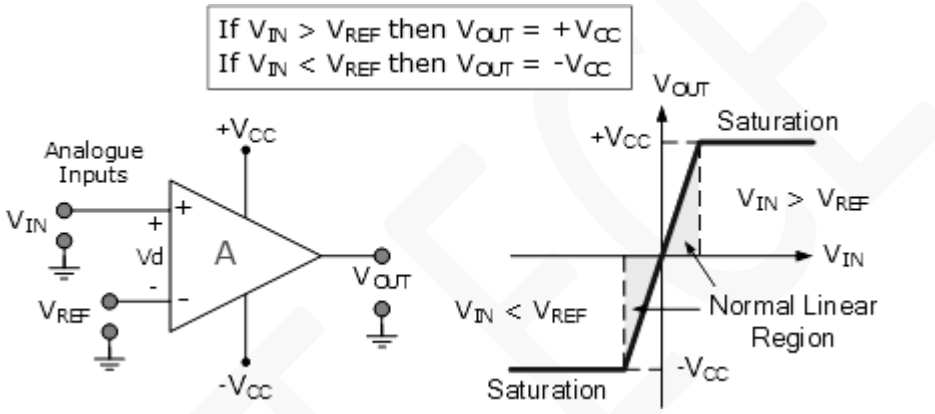
$$\frac{V_o}{V_s} = A_f = \frac{A}{1 + A\beta}$$

Concept: In a negative-feedback amplifier system a portion of the amplified output is feeding to the input but in opposite phase, so that negative feedback opposes the original signal. i.e, input and outputs are out of phase(180^o).

1.c) With circuit diagram and waveform show how operational amplifier can work as a comparator (6 Marks)

OPAMP voltage comparator compares the magnitudes of two voltage inputs and determines which is the larger of the two.

- Referring the figure assume ($V_{IN} < V_{REF}$).
- As the non-inverting (positive) input of the comparator is less than the inverting (negative) input, the output will be the negative supply voltage, -Vcc resulting in a negative saturation of the output.
- When ($V_{IN} > V_{REF}$), the output voltage rapidly switches HIGH towards the positive supply voltage, +Vcc resulting in a positive saturation of the output.

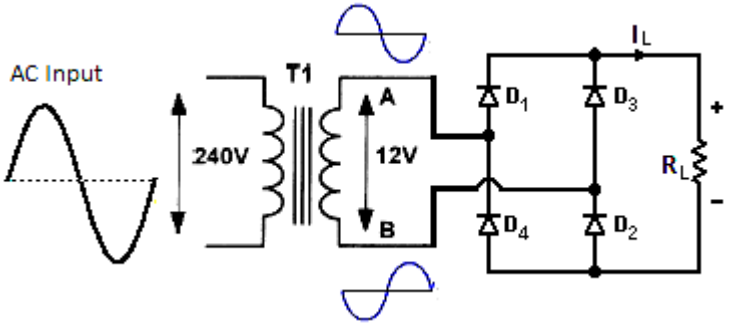


Voltage comparator using OPAMP

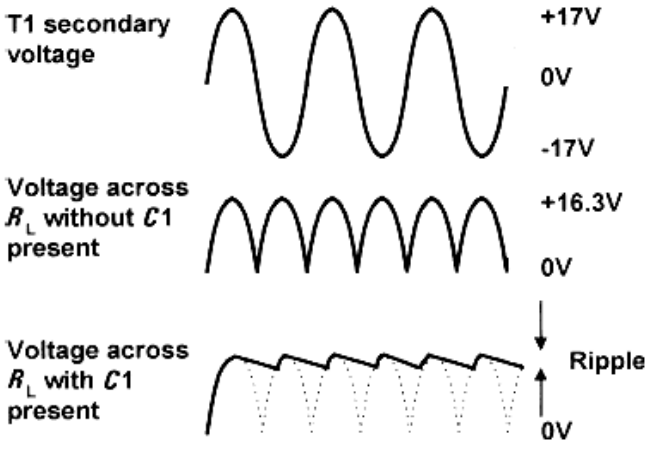
- Suppose the input voltage V_{IN}, is decreased slightly less than V_{REF}, the op-amp's output switches back to its negative saturation voltage acting as a threshold detector.

2.a) With neat circuit diagram and waveforms explain the working of bridge rectifier. (8Marks)

Bridge full wave rectifier employs four diodes, but only two diodes will conduct during each half cycle. The AC mains (240V) is applied to the primary of T1 and secondary windings providing 12V r.m.s, as shown in the fig.



a) Bridge rectifier circuit



b) Input output wave forms

During **positive half cycle**:

Point A will be +ve with respect to point B, then diodes D_1D_2 are forward biased act like closed switches, and hence conduct. While, diodes D_3D_4 are reverse biased act like open switches, hence do not conduct.

During **negative half cycle**:

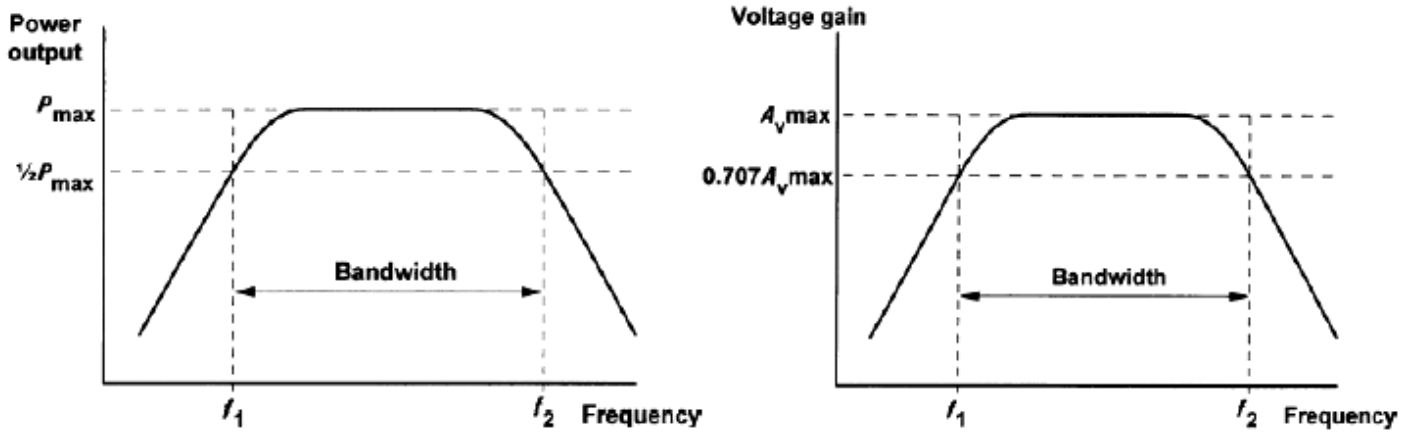
Point B will be +ve with respect to point A, then diodes D_3D_4 are forward biased act like closed switches, and hence conduct. While, diodes D_1D_2 are reverse biased act like open switches, hence do not conduct.

In both +ve and –ve half cycles current I_L flow through load resistance R_L. The complete input-output voltage waveforms of the bridge full wave rectifier are shown in fig.

2.b) Write a note on frequency response characteristics of an amplifier circuit, clearly mentioning the half power frequencies. (6Marks)

Frequency response: It is the graph plotted for gain verses input frequency of an amplifier. The frequency response of an amplifier is usually specified in terms of the upper (f_2) and lower (f_1) cut-off frequencies of the amplifier. These frequencies are those at which the output power has dropped to 50% (otherwise known as the **−3 dB points**) or where the voltage gain has dropped to 70.7% of its mid-band value.

Fig. show how the bandwidth can be expressed in terms of either power or voltage.



Bandwidth: The bandwidth of an amplifier is usually taken as the difference between the upper and lower cut-off frequencies (i.e. $f2 - f1$ in Fig.).

2.c) List and explain conditions for sustained oscillations. Determine the frequency of oscillation of a three-stage ladder network in which C=10 ηF and R=10 kΩ. (6 Marks)

The conditions for oscillation are:

(a) the feedback must be positive

(i.e. the phase shift must be 0^o or 360^o.);

(b) the overall loop voltage gain must be greater than 1

(i.e. the amplifier's gain must be sufficient to overcome the losses associated with any frequency selective feedback network). Hence, to create an oscillator we simply need an *amplifier* with sufficient gain to overcome the losses of the network that provide *positive feedback*.

Problem:

Given data for three-stage ladder network

C =10 ηF and

R =10 kΩ

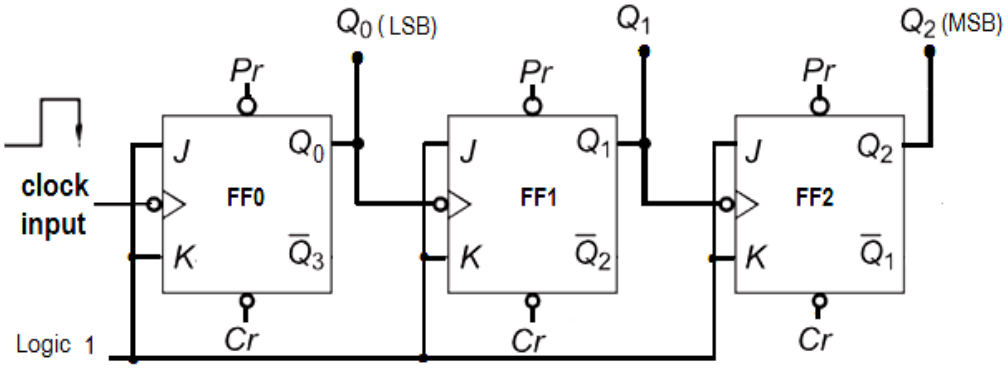
Frequency of oscillations of the circuit is, $f_o = \frac{1}{2\pi RC\sqrt{6}}$

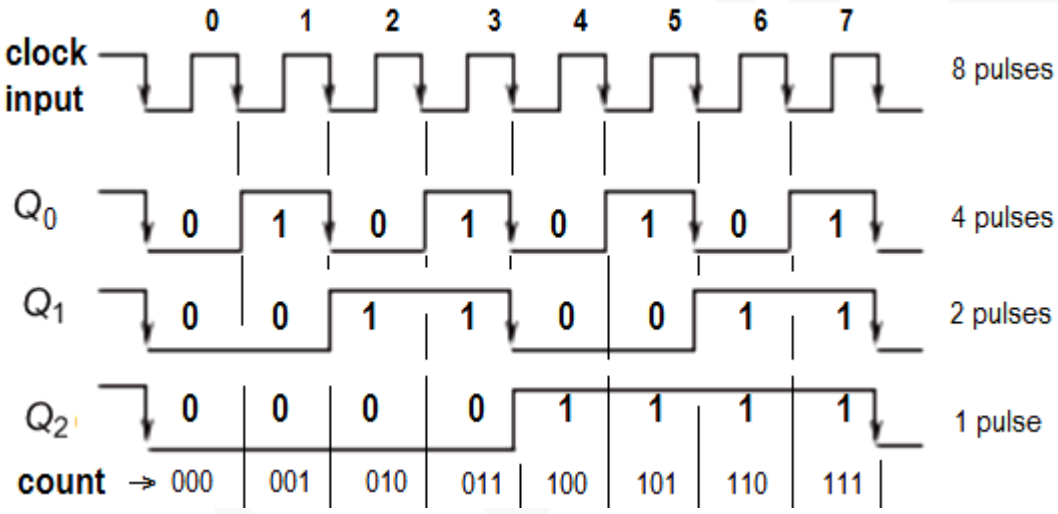
$f_o = 1/(2*\pi*10*10^3*10*10^{-9}*\sqrt{6}) = 649.74 \sim$ **650Hz**

3.a) Discuss the design of a 3-bit asynchronous up-counter (6Marks)

Operation of 3-bit asynchronous counter: It consists of three JK flip-flops with preset (Pr) and clear (Cr). All the flip flops are initially cleared. Logic 1 is provided to all JK input terminals to achieve toggling at the negative transition (NGT pulse transition from 1 to 0) of the applied clock input.

The output of FF0 (Q_0) is applied as clock input for FF1. So, Q_1 toggles for every NGT of Q_0. Similarly, the output of FF1 (Q_1) is applied as clock input for FF2. So, Q_2 toggles for every NGT of Q1. Thus the counter counts from 0 to 7, (i.e, in binary 000 to 111). 3-bit asynchronous counter is depicted in the figure.





Timing diagram of 3-bit asynchronous counter

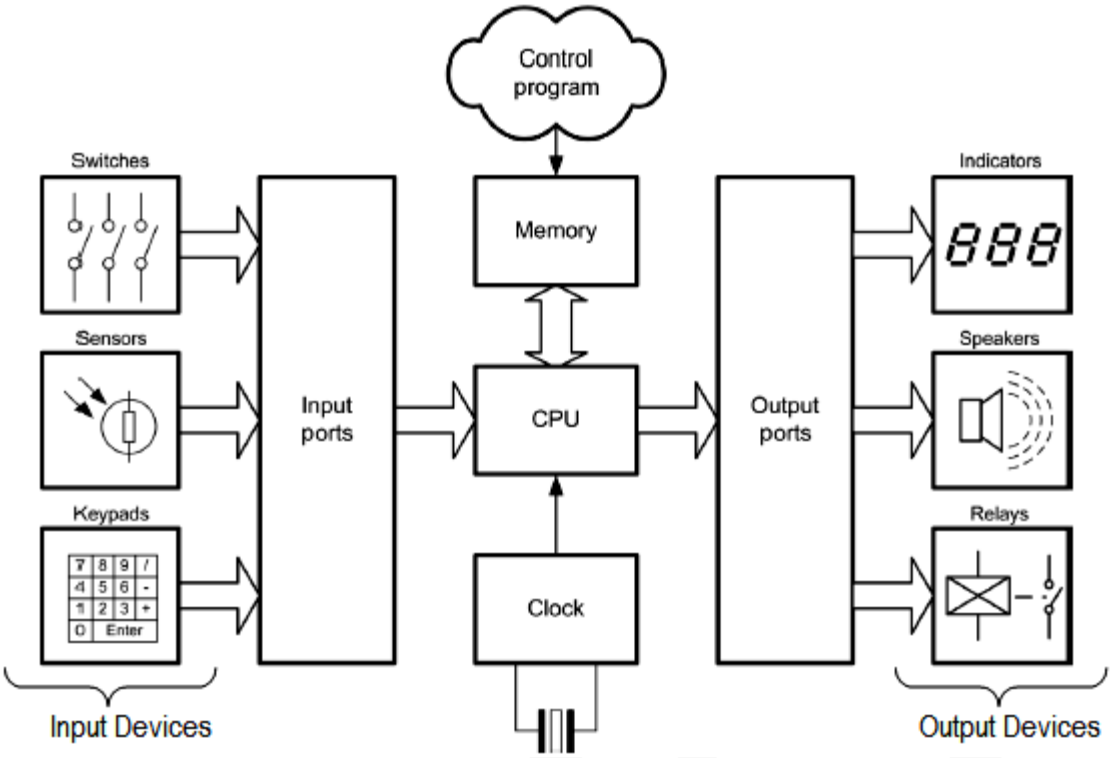
Input Clock	Q_2	Q_1	Q_0
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
8	0	0	0

3.b) With a neat block diagram show how typical input and output blocks are connected to a microcontroller unit. (7Marks)

Microcontroller is a programmable device consists of a central processing unit (CPU), memory, peripherals, and support circuitry on a single chip. The block diagram of microcontroller system is shown in figure.

CPU: It is the main component of the processor that contains Arithmetic Logic Unit (ALU) and Control Unit (CU). It control and manages all processes that are carried out in the microcontroller unit. It also communicates devices like memory, input ports, output ports and clock unit.

Control Program: The operation of the microcontroller is controlled by a sequence of software instructions known as a control program that examining inputs from input devices and output signals sent to controlled devices.

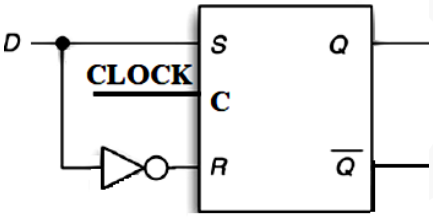


Input devices: Input ports are mainly used to communicate with various input devices such as switches, sensors and keypads. Sensors convert physical quantities (temperature, position, etc.) into corresponding electrical signals.

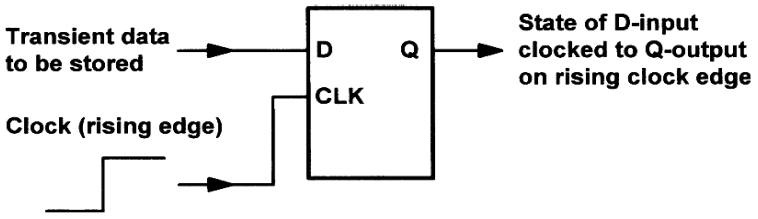
Output devices: Output ports are mainly used to communicate with various output devices such as LED indicators, printers, speakers, relays, motors, etc. Output devices are used to convey information to the outside world.

3.c) With the help of a timing diagram explain how D-type bistable circuit works. (7Marks)

The D-type bistable has two inputs: D ('data' or 'delay') and CLOCK (CLK). The data input (logic 0 or logic 1) is clocked into the bistable such that the output state only changes when the clock changes the state. Operation is thus said to be synchronous.

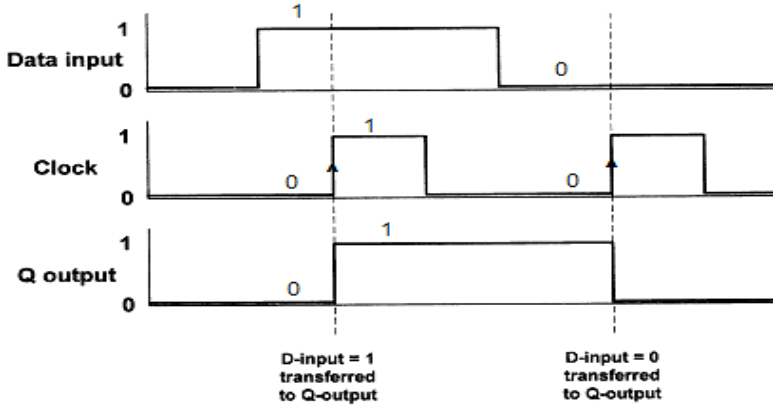


Block diagram of D Type Bistable



Truth Table

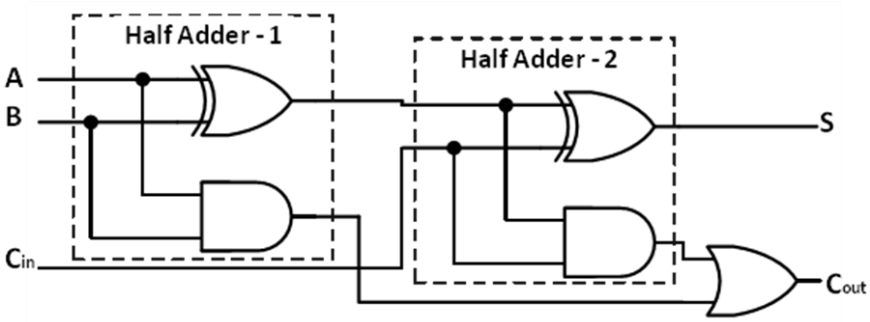
Clock	D	Q	$\overline{Q}$	Description
↓ (0)	X	Q	$\overline{Q}$	Memory no change
↑ (1)	0	0	1	Reset Q = 0
↑ (1)	1	1	0	Set Q = 1



Whenever the CLK signal is LOW, the input is never going to affect the output state. Any logic state of the input (D) will appear at output Q only if the rising edge of the clock is applied. Thus, D flip-flop is a controlled Bi-stable latch where the clock signal is the control signal.

4.a) Design a full adder using two half adders and an OR-gate. (8Marks)

Full adder circuit consists of three inputs (A, B and Cin) and two outputs (S and Cout). It adds these three input bits at a time and produce a carry (C) and sum (S). This process follows the binary addition rules. Circuit can be constructed using two half adders where it consists 2 ANDs, 2 XORs, and one OR gate.



Inputs			Outputs	
A	**B**	**C_{in}**	**Sum (S)**	**Carry (C_{out})**
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

From the truth table it is observes that,

(i) Sum (S) output is equal to 1, when only one input is equal to1 or when all three inputs are equal to1. For this Boolean expression can be written as

$$\text{Sum} = \bar{A}\,\bar{B}\,C_{in} + \bar{A}\,B\,\bar{C}_{in} + A\,\bar{B}\,\bar{C}_{in} + A\,B\,C_{in}$$

(ii) Output has a carry1, if two or three inputs are equal to1. For this Boolean expression can be written as

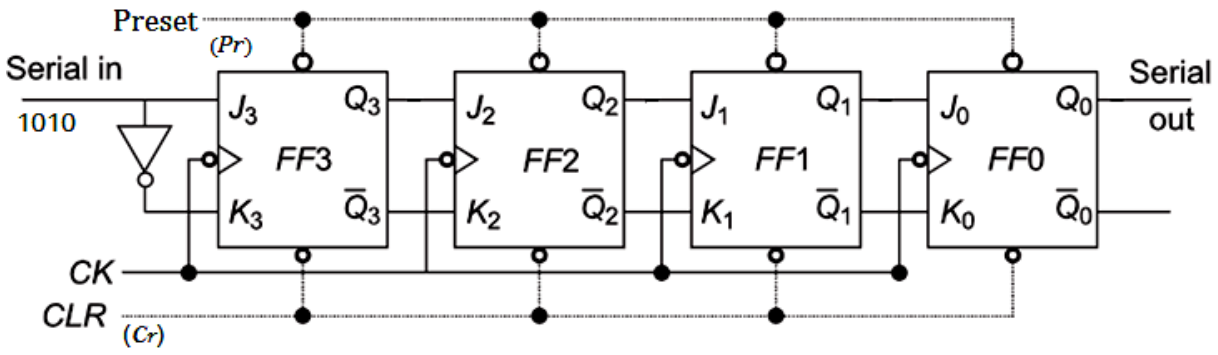
$$C_{out} = AB + AC_{in} + BC_{in}$$

For sum and carry out Boolean expressions are given above.

4.b) Design a 4-stage shift register using J-K bistables. (7 Marks)

Shift Register: It is a sequential circuit is used to *store* and *transfer* of binary data.

From the figure, all flip-flops are cleared, by making clear (CLR) = 0. During normal operation CLR =1. Also, make preset Pr = 0, to avoid interference between normal operation. All flip-flops are triggered by common clock pulse (CK). During each clock pulse, one bit of input data is transmitted from FF3 to FF0.



For example, input data (1010) has to be shifted through the register from FF3 to FF0. LSB (0) is passed first and MSB (1) is passed last to FF3.

After first clock pulse: $Q_3 = 0$, $Q_2 = 0$, $Q_1 = 0$, $Q_0 = 0$
LSB (0) is entered into FF3 (as given function table), hence the output of FF3 is $Q_3 = 0$.

After 2 clock pulses: $Q_3 = 1$, $Q_2 = 0$, $Q_1 = 0$, $Q_0 = 0$
Data **0** from Q_3 is shifted to FF2, and its output $Q_2 = 0$, while **1** from input data is entered into FF3, and its output $Q_3 = 1$.

Similarly, when we apply clock pulses after 4 clock pulses: $Q_3 = 1$, $Q_2 = 0$, $Q_1 = 1$, $Q_0 = 0$
Data **0** from Q_1 is shifted to FF0, and its output $Q_0 = 0$, data **1** from Q_2 is shifted to FF1, and its output $Q_1 = 1$ and data **0** from Q_3 is shifted to FF2, and its output $Q_2 = 0$, while **1** from input data is entered into FF3, and its output $Q_3 = 1$.

Clock Pulse	Serial In	Q_3	Q_2	Q_1	Q_0 (Serial Out)
↑	**1010**	**0**	0	0	0
↑	**101**	**1**	**0**	0	0
↑	**10**	**0**	**1**	**0**	0
↑	**1**	**1**	**0**	**1**	**0**
↑	0	0	**1**	**0**	**1**
↑	0	0	0	**1**	**0**
↑	0	0	0	0	**1**
↑	0	0	0	0	0

4.c) Write a note on different data types mentioning the bit size and range of values supported. (5Marks)

Data types

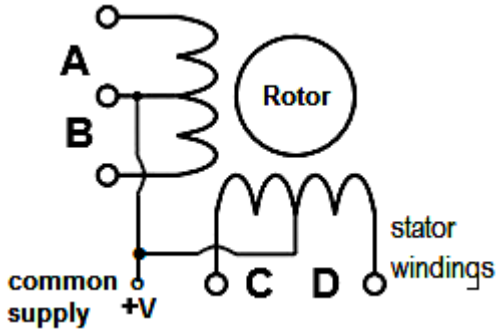
Data type	Bits	Range of Values	Binary representation
Unsigned byte	8	0 to 255	0000 0000 - 1111 1111
Signed byte	8	-128 to + 127	1000 0000 - 0111 1111
Unsigned word	16	0 to 65,535	0000 0000 0000 0000 - 1111 1111 1111 1111
Signed word	16	- 32,768 to +32,767	1000 0000 0000 0000 - 0111 1111 1111 1111

Module-3

5.a) Explain the working, principle of operation and applications of stepper motor. (8Marks)

Definition: A Stepper motor is an electro-mechanical device which generates discrete rotation in response to dc electrical signals.

Stepper motor rotor has a permanent magnet and the stator has four electromagnetic coils which remain stationary.



Working: Stepper motor rotor has a permanent magnet and the stator has four coils which remain stationary.

When current is supplied to the stator windings, magnetic field is generated, in turn, rotor rotates. As stator windings are energized step by step in a particular order, the stepper motor rotates in discrete steps.

Principle: (Electromagnetic induction) Whenever the coils energized by applying the current, the electromagnetic field is created, resulting the rotation of rotor. Coils should be energized in a particular sequence to make discrete rotation of the rotor.

Applications: in industrial embedded applications,
consumer electronic products, robotics, control system,
dot matrix printers, disk drives, etc.

5.b) Write a note on classification of embedded systems. (6Marks)

Classification of embedded systems

- Based on Generation
- Based on Complexity & Performance Requirements
- Based on deterministic behavior
- Based on Triggering

Based on Generation

First Generation: 8-bit microprocessors and 4-bit microcontrollers. Such embedded system possesses simple hardware and firmware developed using assembly code.

Ex: Digital telephone keypads, stepper motor control units.

Second Generation: 16-bit microprocessors and 8-bit microcontrollers. They are more powerful and complex compared to first generation.

Ex: Data acquisition systems, SCADA systems.

Third Generation: 32-bit microprocessors and 16-bit microcontrollers. Hence, its operation has become much more powerful and complex than the second generation.

Ex: Robotics, industrial process control, embedded networking.

Fourth Generation: Embedded Systems built around SoCs, multi-core processors, coprocessors. More powerful performance

Ex: Smart devices, digital cameras, etc.

Based on Complexity & Performance Requirements

Small Scale Embedded Systems: are built with a single 8 or 16-bit microprocessor or controller. The main programming tools used are an editor, assembler, cross assembler and integrated development environment. Ex: An electronic toy

Medium Scale Embedded Systems: are built with 16-bit or 32-bit microprocessor or controller, ASICs or DSPs. They have both hardware and software complexities. Ex: ATM

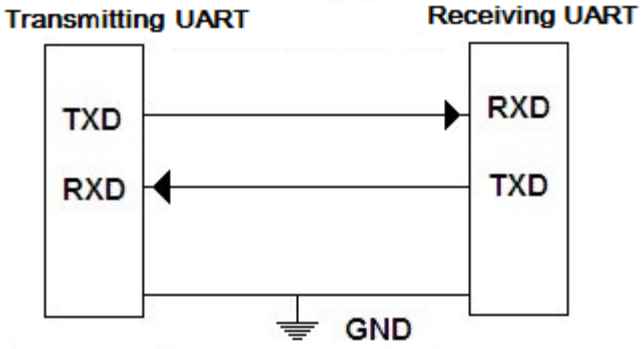
Large scale Embedded Systems: They built around 32-bit or 64-bit processors/controllers, RISC processors, SoC (System on Chip).

Ex: Robots

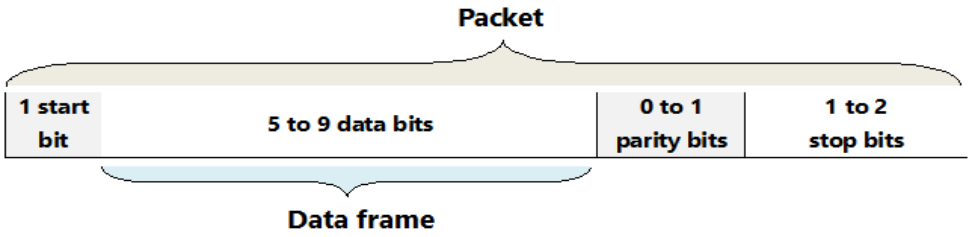
5.c) Bring out the main features of UART and USB. (6marks)

UART (Universal Asynchronous Receiver Transmitter)

In UART communication, two UARTs will communicate directly with each other. Only two wires are needed to transmit data between two UARTs. Data flows from the TXD pin of the transmitting UART to the RXD pin of the receiving UART and vice versa, as shown in the figure.



UART data transmission has no clock signal to send/receive information. Instead of a clock signal, the transmitting UART consists *start* and *stop* bits with the *data packet* being transferred.



Start bit: The UART data transmission line is normally held at *logic-1* when it's not transmitting data. To start the transfer of data, UART pulls the transmission line from *logic-1* to *logic-0.*

Data Frame: The data frame contains the actual data being transferred. It can be 5 bits up to 8 bits long.

Parity bit: It counts the number of 1's and checks if the total is an even or odd number. If the parity bit = 0 (even parity), otherwise odd parity.

Stop Bits: To indicate the end of the data packet.

Universal Serial Bus (**USB**): is a wired high speed serial bus for data communication that enables universal communication between the peripheral devices and a host controller. The USB host controller is responsible for controlling the data communication, including establishing connectivity with USB slave devices, packetizing and formatting the data packet.

USB 2.0 cable

For example, USB 2.0 cable, has four shielded wires.

Red wire (1) for power supply voltage (+5V) and black wire (4) for ground that allow the device to be powered by the host through the USB connection. The other two wires, green wire (3) is for the data (D+) upstream and white wire (2) is for data (D-) downstream are responsible for the transmission of the data.

Pin	Name	Cable color	Description
1	VCC	Red	+5 VDC
2	D-	White	Data -
3	D+	Green	Data +
4	GND	Black	Ground

The USB cable supports communication distance of up to 5 meters.

6.a) Give the classification of transducers with examples. (6 Marks)

Transducers are devices that convert energy in the form (sound, light, heat, etc.) into an equivalent electrical signal, or vice versa.

Classification of sensors:

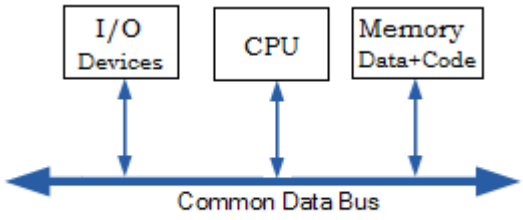
1. Active Transducers Example: Thermocouple, Photodiode, Piezoelectric sensor.
2. Passive Transducers Example : Strain gauge.
3. Contact type***:*** A sensor that requires physical contact with the parameter to be measured.
   Example: Strain gauges, temperature sensors.
4. Non-contact type***:*** It requires no physical contact.
   Example: Optical Transducers, Magnetic sensors, Infrared thermometer.
5. Analog and Digital Transducers Example: accelerometers
6. Primary Transducer (Ex: bourdon tube) and Secondary Transducer (Ex: LVDT)
7. Based on the Physical Parameter being measured Example: Flow, Level, Temperature, Pressure, etc.

6.b) Bring out the differences RISC & CISC, Harvard & Von-Neumann (6Marks)

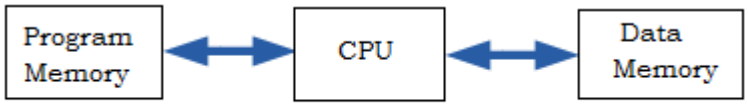
RISC	CISC
Reduced Instruction Set Computer.	Complex Instruction Set Computer.
Software centric design.	Hardware centric design.
Low power consumption.	High power consumption.
Requires more RAM	Requires a minimum amount of RAM

Simple decoding of instruction.	Complex decoding of instruction.
Processors are highly pipelined.	Processors are not pipelined or less pipelined.
Execution time is very less	Execution time is very high
Uses multiple registers.	Uses a single register.

The terms Harvard and Von-Neumann refers to the processor architecture design is depicted as shown below.



Von-Neumann Architecture



Harvard Architecture

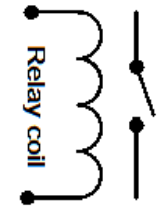
It is ancient computer architecture based model.	It is modern computer architecture based model.
CPU is connected data memory (RAM) and program memory (ROM) by a single memory.	CPU is connected data memory (RAM) and program memory (ROM), separately.
CPU cannot access instructions and data at the same time.	CPU can access instructions and data at the same time.
Same physical memory address is used for instructions and data.	Separate physical memory address is used for instructions and data.

6.c) Define 'Actuator' and briefly describe the following actuators - relay, Piezo-buzzer (8Marks)

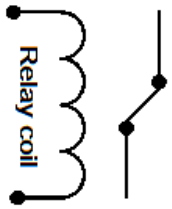
Actuator is a transducer which converts electrical signals to corresponding physical action (motion). Actuator acts as an output device.

Relay: An electro mechanical device which acts as a dynamic path selector for signals and power. Relay works on *electromagnetic* principle.

When a voltage is applied to the relay coil, current flows through the coil, which in turn generates a magnetic field. The magnetic field attracts the armature core and moves the contact point. The movement of the contact point changes the path of power/signal.



Single Pole Single Through Normally Open (NO)



Single Pole Single Through Normally Closed (NC)

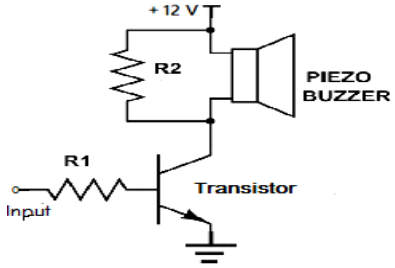
Piezo-buzzer: It is a piezoelectric device for generating audio indications in embedded applications. A Piezo buzzer contains a piezoelectric diaphragm which produces audible sound in response to the voltage applied to it. Buzzer can be used as an alarm or as a fire alarm or as an intruder alarm.

When AC voltage is applied to the piezo-ceramic element, that extends and shrinks diametrically. This characteristic of piezoelectric material is utilized to make the ceramic plate vibrate rapidly to generate sound waves.

Piezoelectric buzzers are available in two types:

1. **Self-driving and 2. External driving**

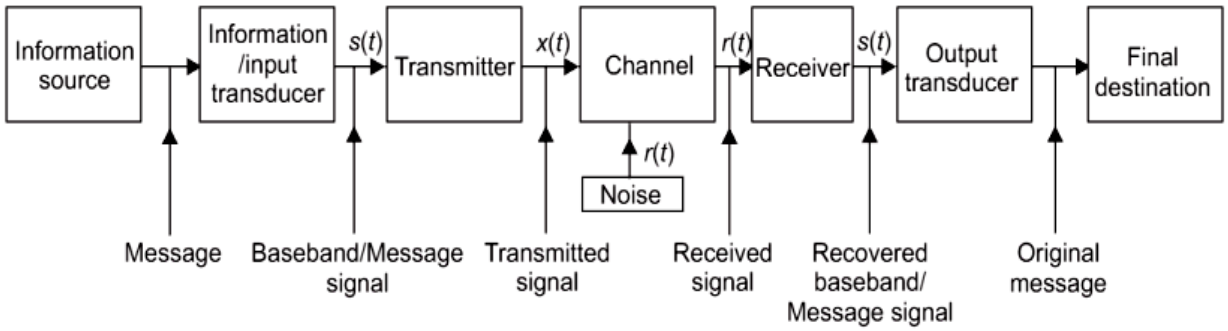
External driving piezo buzzers supports the generation of different tones.



7.a) Describe the blocks of the basic communication system. (6 Marks)

Basic Elements of Communication System

- Information source and transducer
- Transmitter
- Channel or medium
- Noise
- Receiver
- Output transducer and final destination



- Message or information originates in the information source may be in the form of sound (human speech), picture (image source), words (text).
- Input transducer converts the non-electrical signal (Ex: sound signal or light signal) into an electrical signal.
- Transmitter *performs modulation, filtering and amplification*. In modulation, the message signal is superimposed upon the high-frequency carrier signal.
- Channel means the medium through which the message travels from the transmitter to the receiver. Mainly there are two types:
  - **Hardwired channels** (Manmade structure)

  Twisted pair cables used in telephony, in which two conductors are twisted together.
  Coaxial cable used in TV transmission, to carry high-frequency electrical signals with low losses.
  Waveguide: consisting of a hollow, metal tube of uniform cross-section
  Optical Fibre: consist of very thin hollow glass fibre through which light signal.
  - **Soft-wired channels** (no physical link between transmitter and receiver)

  Natural resources air or water can be used as the transmission medium for signals.
  Example**:** Radio signals in open space and Sea water.
- When *noise* is mixed with the transmitted signal, it rides over it and deteriorates the information.
- The main function of the receiver is to reproduce the original message signal. This reproduction of the original signal is accomplished by a process known as the demodulation or detection.
- Destination is the final stage which is used to convert an electrical message signal into its original form.

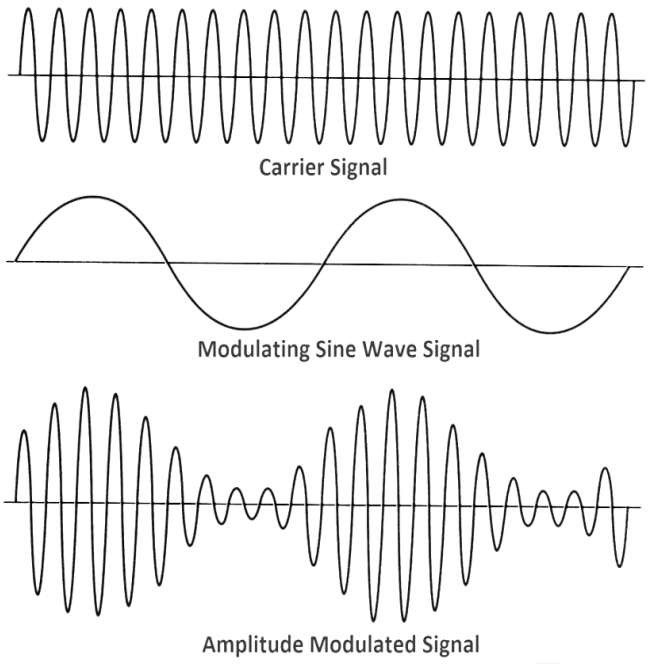
7.b) Define the following terms: (i) Modulation (ii) Carrier communication system (iii) Baseband communication system with neat and suitable waveforms. (6Marks)

(i) Modulation: It is the process in which any one of the parameters (amplitude, frequency or phase) of the high frequency carrier signal is varied according to the instantaneous values of the low frequency message signal, keeping other parameters constant.

(ii) Carrier communication system:

The baseband signal is super imposed with a higher frequency carrier signal by modulation process.

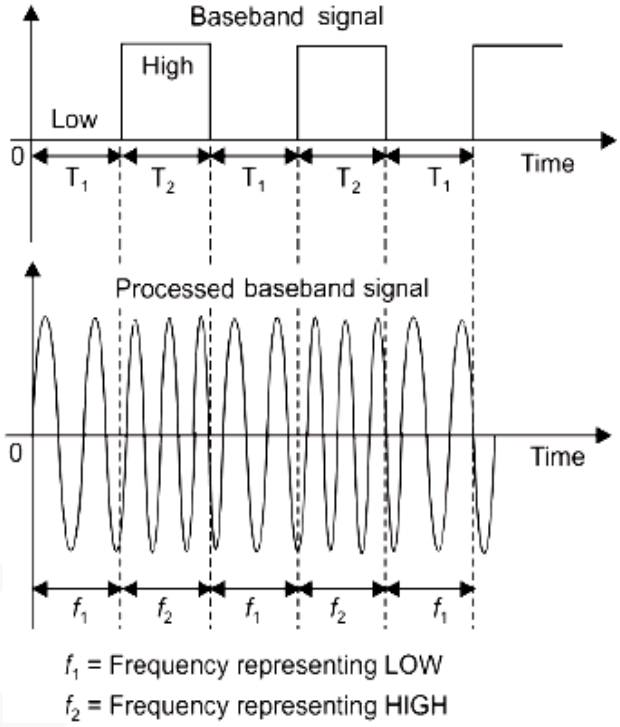
Ex: Radio, TV broadcasting



(iii) Baseband communication system:

The baseband signal is transmitted without translating it to a higher frequency spectrum.

Ex: Land line telephone communication



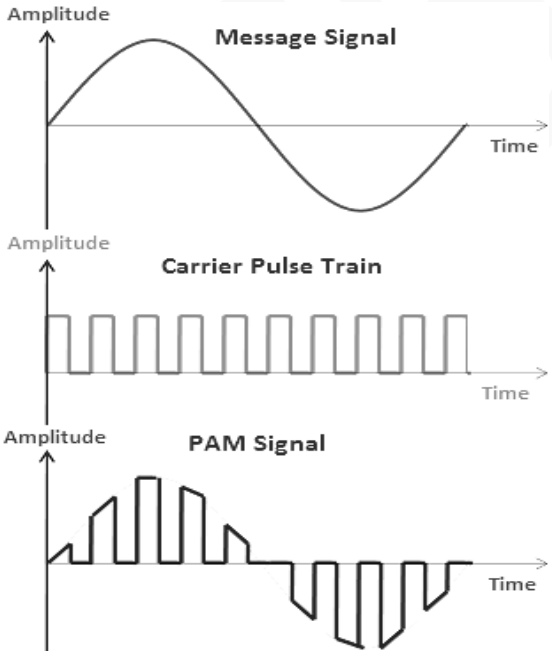
f_1 = Frequency representing LOW

f_2 = Frequency representing HIGH

7.c) Explain the following with the help of waveforms. (i) PAM (ii) PWM (iii) PPM (iv) PCM (8Marks)

Pulse Amplitude Modulation (PAM):

The technique in which the amplitude of the carrier pulse varies proportional to the instantaneous amplitude of the message signal.

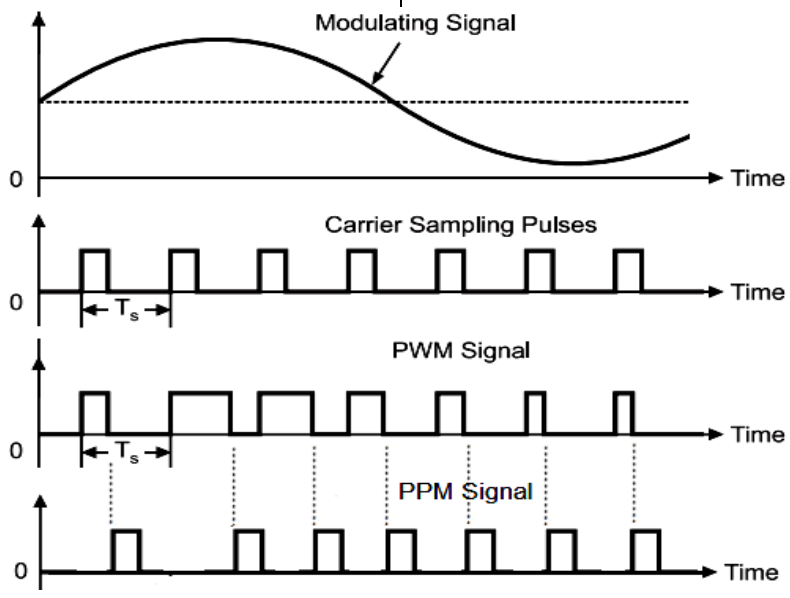


Pulse width modulation (PWM):

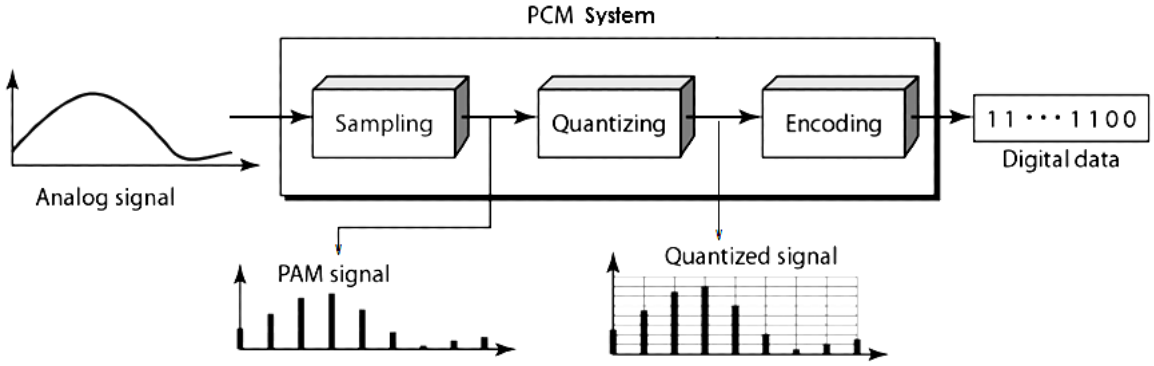
The technique in which each pulse duration is made proportional to instantaneous values of the modulating signal while, starting time and amplitude is constant.

Pulse Position Modulation (PPM):

In PPM, the amplitude and width of the pulses are kept constant and only the position of the pulses is varied in accordance with the amplitude of the message signal.



PCM: It is a modulation technique in which analog signal gets converted into digital form by three consecutive processes: sampling, quantization and encoding.



8.a) Define sampling theorem and explain when aliasing can happen. Also mention the different ways in which aliasing can be avoided. (6Marks)

Sampling theorem: A band limited analog signal can be sampled and perfectly reconstructed from its samples if the sampling frequency is at least twice the maximum frequency of the base band signal.

i.e, $f_s \geq 2f_{max}$

Aliasing is an effect of the sampling that causes different signals to become indistinguishable.

Aliasing occurred when $f_s < 2f_{max}$.

Different ways to avoid aliasing effect:

Aliasing is avoided by:

i) To obtain the band-limited signal introducing analog low pass (anti aliasing) filter processes

ii) Sampling the signal at a higher rate than the Nyquist rate ($f_s \geq 2f_{max}$).

8.b) Define the following terms: Multipath, Constructive and destructive interference, Coherence time, Coherence bandwidth, Delay spread (10Marks)

Multipath: As a result of reflections and diffractions the signals can take several different paths from the transmitter to the receiver. This phenomenon is known as *multipath.*

Constructive and destructive interference: At the receiver end, the incoming rays can add together in different ways, which are classified as *constructive interference* and *destructive interference.*

If the peaks of the incoming rays coincide, then they reinforce each other, a situation known as *constructive interference*. If the peaks of one ray coincide with the troughs of another, the result is *destructive interference*, in which the rays cancel.

Coherence time, Coherence bandwidth, Delay spread

The amplitude and phase of the received signal vary over a time scale called the *coherence time*, T_c that can be estimated as

$$T_c = \frac{1}{f_D}$$

Where, f_D is mobile *Doppler frequency*, given by

$$f_D = \frac{v}{c} f_c$$

Where, f_c is carrier frequency, v is speed of mobile and c is speed of light ($3x10^{-8}$m/s)

If the carrier frequency changes, wavelength of the radio signal also changes. This makes the pattern change between constructive and destructive interference. The amplitude and phase of the received signal vary over a scale called the *coherence bandwidth*, B_c that can be estimated as

$$B_c = \frac{1}{r}$$

Where, r is delay speed of radio channel.

8.c) Define an antenna and discuss different types of antennas. (4 Marks)

Antenna is a device used for converting electromagnetic radiation in space into electrical currents in conductors or vice-versa, depending on whether it is being used for receiving or for transmitting, respectively.

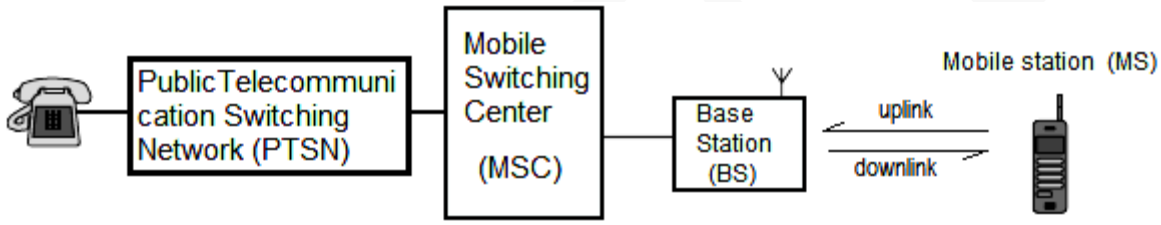
Types of Antenna

- Omni-directional Antennas
- Dipole Antennas
- Collinear omni Antennas
- Directional Antennas
- Patch Antennas
- Patch Array Antennas
- Yagi Antennas

Module-5

9.a) Draw the schematic diagram of a cellular telephone system and define its basic components. (6 Marks)

Cell: A basic geographical service area (5-20kms) of a cellular communication system. Each cell is allocated a band of frequencies and is served by a base station.



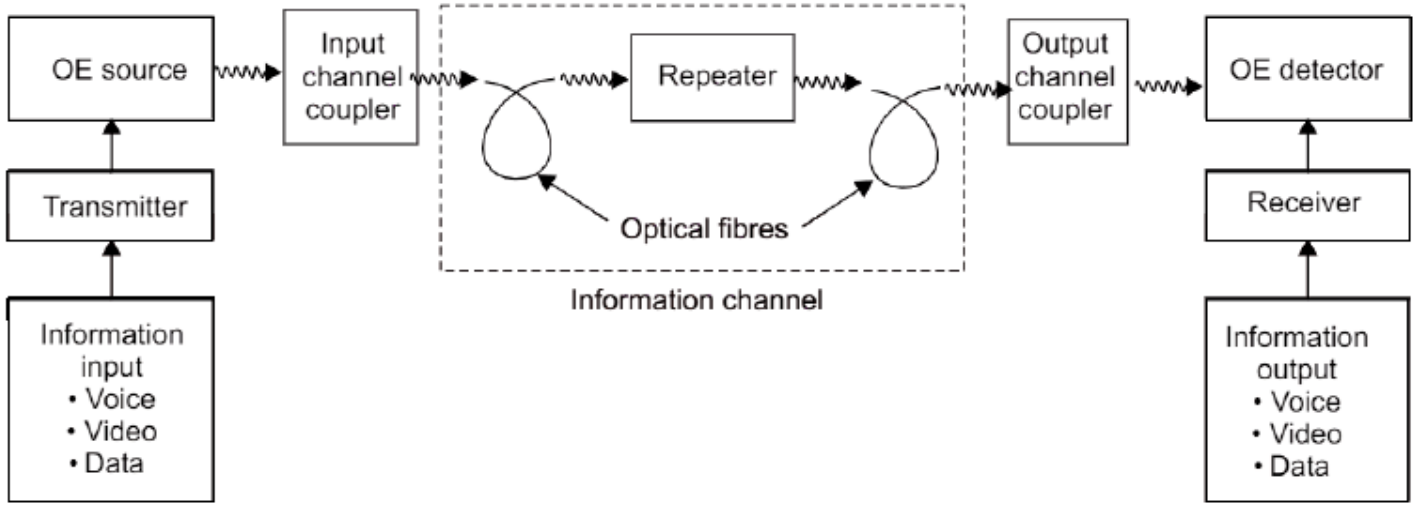
Mobile Station (MS): This is the mobile handset. It consists: i) subscriber identity module (SIM) which stores all the user specific data ii) software needed for communication with a mobile network.

Base Station (BS): Each cell contains an antenna, which is controlled by a small office called base station, consisting of transmitter, receiver, and control unit. Each BS is controlled by a MSC office.

Mobile Switching Center (MSC): It is the primary service delivery node which is responsible for connecting calls, SMS and other services such as conference calls, FAX, billing.

9.b) Explain the optical fiber communication system with a block diagram. (6Marks)

The generalized configuration of a fiber-optic communication system is (shown in the fig.) described as follows:



Information input: It receives information in physical forms (for example, voice, video and data) and passed over to transducer. Input transducer (sensor) converts the physical signal into electrical signal.

Transmitter (Modulator): The role of the optical transmitter is to:

- convert the electrical signal into optical form
- couple (launch) the resulting optical signal into the optical fiber

The optical transmitter consists of driver circuit and optical source which impresses the signal onto EM wave. OE source generates the EM wave (light) acts as a carrier in optical range. Common sources for fiber optic are – LED and ILD (injection laser diode).

Coupler: It collects light signal from the OE source and sends it efficiently to the optical fiber cable. Coupling losses may be large due to reflection and limited light gathering capacity of the couplers.

Information channel is an optic cable consisting of single or bundle of fibers. The optical fiber acts as a wave guide and transmits the optical pulses towards the receiver, by the principle of total internal reflection.

Repeater : After certain long distance optical signals become weak and degrade, due to scattering, absorption and dispersion. The repeater used for restoring the strength and shape of the signal.

Photo detector: This converts the optical signal to electrical signal. For this semiconductor PIN diodes or avalanche photodiodes are used. The photo current developed is proportional to the incident optical power.

Receiver: The output of the photo detector (photocurrent) is filtered to remove the dc bias. After filtering the photocurrent, it is amplified if needed. Then the receiver converts the light signal into electrical form.

9.c) With the help of diagrams, discuss the following types of network topologies: Ad-Hoc Network Topology, Infrastructure Network Topology (8Marks)

Wireless network topology is the way of network components are arranged.

There are TWO types of topologies used in wireless networks:

1. Ad – Hoc Network Topology
2. Infrastructure Network Topology

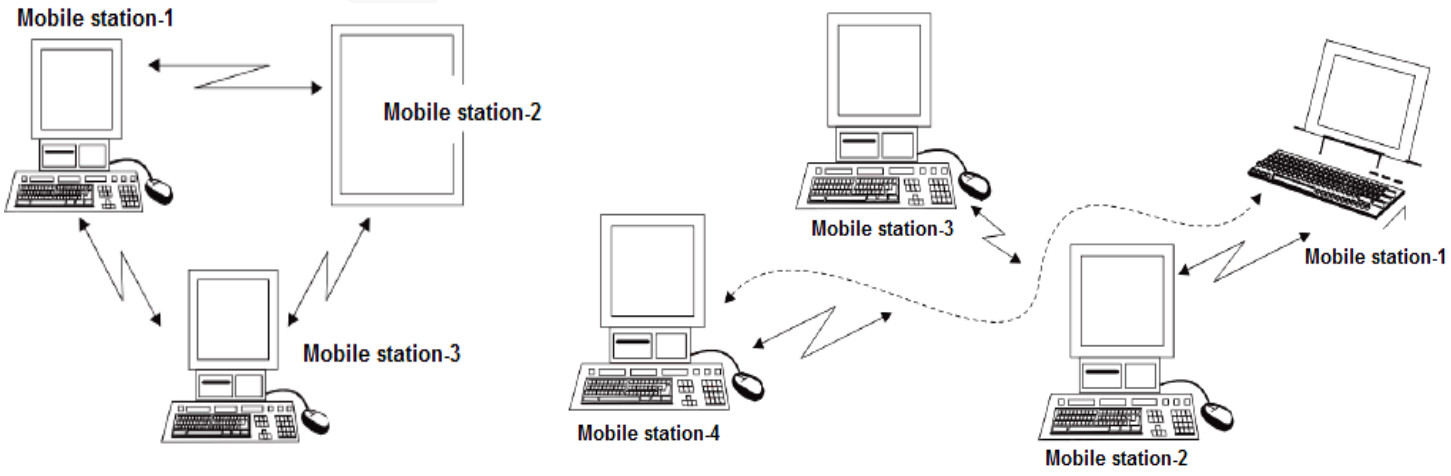
1. Ad – Hoc Network Topology: Wireless devices communicate directly with each other without any access point (AP). Ad hoc network is also known as IBSS (Independent Basic Service Set) configuration.

Single ad-hoc network: Without Base Station, each node can communicate wirelessly with each other within their radio range. This is suitable for rapid wireless communication.

Application: Military- establishing common communication among soldiers for voice and data, Collaborative – conference held among groups

Multi ad-hoc network: In multi-hop ad-hoc network, the coverage area is larger than radio range of single nodes. Therefore, to reach some destination a node can use other nodes as relays.

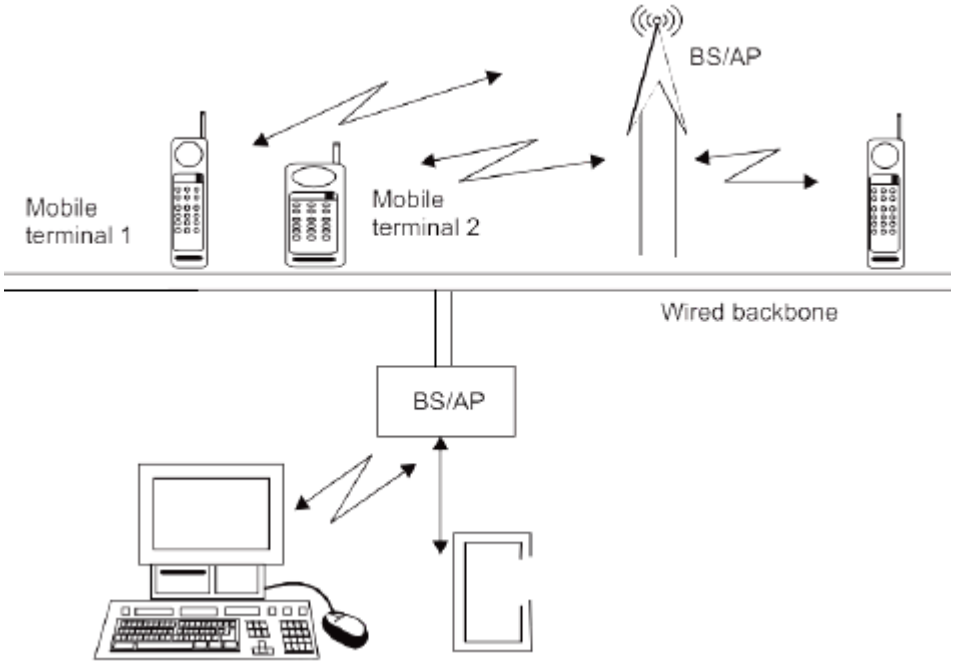
Single ad-hoc network *Multi ad-hoc network*



2. Infrastructure Network Topology

In this topology, there is a fixed infrastructure that supports the communication between the mobile terminals and fixed terminals. This topology is often designed for large coverage areas and multiple base stations.

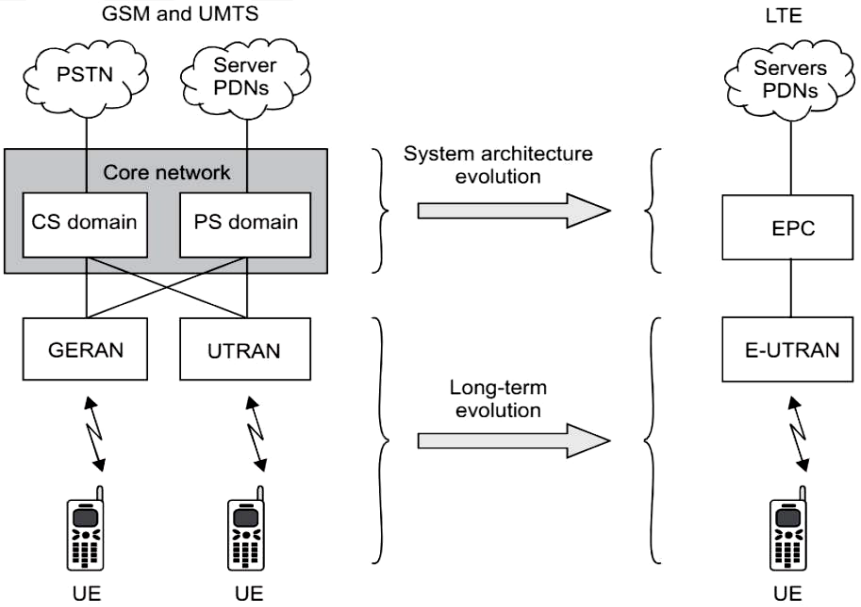
As in the figure, BS serves as the hub of the network and MS located at different points. Basically, communication comes from BS/AP to all users. If the coverage area is larger, then wired backbone will be communicated the end devices via sub-access pointers or sub- base stations.



10.a) With the help of architecture figures explain the evolution from GSM to LTE. (8Marks)

The 3rd Generation Partnership Project (3GPP) has redesigned both the radio access network (RAN) and the core network (CN) is brand named as LTE. LTE uses OFDM with QAM modulation in 10 - 20 MHz channels to provide downlink data rates of up to 100 mbps.

UMTS (Universal Mobile Telecommunication Services) is the main technology responsible behind 3G. *Universal Terrestrial Radio Access Network* (UTRAN) consists of multiple *Radio Network Sub-systems* (RNSs) which is equivalent to the *base station subsystem* (BSS).



GERAN = GSM EDGE Radio Access Network

The main function of the CN is to perform packet routing, connection of users, security, billing and the connection of UMTS to external packet switched (PS) and circuit switched (CS) networks. CS domain and PS domain provide a common connectivity to CN with the help of GERAN and UTRAN.

The EPC in the LTE technology supports access to the PS domain and provides no support for the CS domain. The Evolved UTRAN (E-UTRAN) is the network that distributes voice and data using the PS technologies. Voice calls are transported using voice over IP.

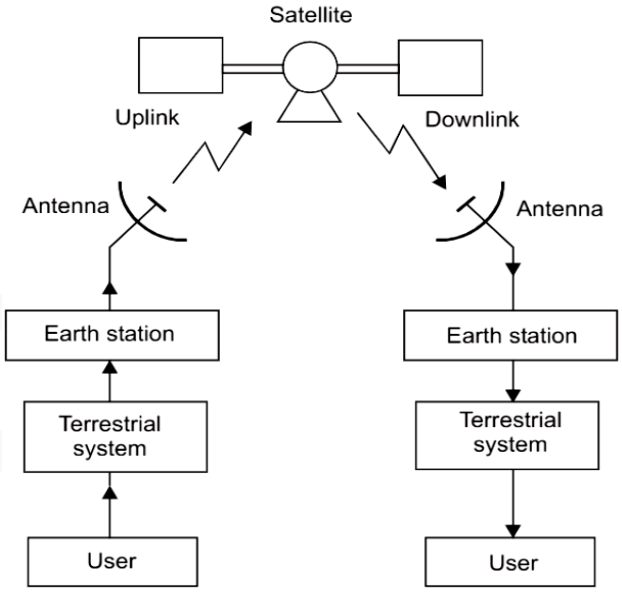
10.b) List the requirements identified for the 4G technology. (4Marks)

The *high level requirements* for a 4G technology were identified as:

i) High spectral efficiency
ii) Reduced cost per bit
iii) Increased services by increasing the efficiency
iv) Open interfaces
v) Power efficiency
vi) Flexible usage of frequency bands

10.c) Draw the block diagram showing the basic elements of a satellite communication system and briefly explain them. (8Marks)

The basic elements of a satellite communication system (as illustrated in the fig.) are:
User, Satellite, Terrestrial Network System and Earth Station



User: The user generates baseband signal that propagates through a terrestrial network and transmitted to the satellite from earth station.

Terrestrial network: This is a network on ground which carries the signal from user to earth station. Also it can provide audio, video and data communication for users within a local geographical area.

Earth station: It is a radio station located on earth that sends /receives the signals from satellites. The *earth station* is responsible for controlling the satellite if it drifts from its orbit when it is subjected to any kind of drag from the external forces.

Satellite: It is a repeater (transponder) in space that receives the RF modulated carrier from all earth stations in the uplink and amplifies before sending in the downlink. The frequency with which, the signal is sent into the space is called as *uplink frequency* (5.9 - 6.4 GHz). Similarly, the frequency with which, the signal is sent by the transponder is called as *downlink frequency* (3.7 - 4.2GHz). Higher frequency is assigned for uplink, to avoid interference.

Model Question Paper-II with effect from 2021 (CBCS Scheme)

USN | | | | | | | | | | |

First/Second Semester B.E Degree Examination

Basic Electronics & Communication Engineering

Max. Marks: 100

Note: 01. Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.

Module -1 (Power Supplies, Amplifiers, Operational amplifiers, Oscillators)			**Marks**
Q.01	a	Explain the working of Bi-phase Full wave rectifier circuit with neat diagram.	8
	b	List and describe the main types of amplifiers.	7
	c	Describe the working of a single stage astable oscillator using an opamp.	5
OR			
Q.02	a	Explain the operation of a simple shunt Zener voltage regulator.	7
	b	Sketch the circuit of each of the following based on the use of operational amplifiers (a) comparator (b) a differentiator (c) an integrator (d) Inverting Amplifier.	8
	c	With circuit diagram explain the following: Voltage Doubler, Voltage Tripler	5
Module-2 (Logic Circuits, Data representation, Shift registers, Counters)			
Q. 03	a	Design a 3-to-8 Decoder and show its implementation using basic gates.	8
	b	Construct a logic circuit that will produce a Logic 1 output whenever two or more of its inputs are at Logic 1.	7
	c	With the help of truth table explain full adder using logic gates.	5
OR			
Q.04	a	Explain Input and output states for a J-K bistable using clocked operation.	8
	b	With the help of a neat diagram explain the 4-bit shift register operation and types.	7
	c	With a neat block diagram explain the arrangement of a microcontroller system with typical inputs and outputs.	5
Module-3 (Embedded Systems, Sensors and Interfacing, Actuators, Communication Interface)			
Q. 05	a	Compare Embedded systems and general computing systems. Also provide major application areas of Embedded Systems.	8
	b	Explain the different configurations of 7-segment LED Display.	6
	c	Describe the matrix keyboard interfacing and UART.	6
OR			

Q. 06	a	Define 'sensors' and give its classification with examples.	6
	b	With relevant diagrams explain the operation of Relay, push button and Piezo-buzzer.	8
	c	Explain the following external communication interfaces: USB, wi-fi	6
Module-4 (Analog and Digital Communication)			
Q. 07	a	Define and explain SNR, Noise Figure, channel types, amplitude modulation.	8
	b	Present the architecture of a wireless communication transmitter and its modulation scheme QPSK with waveforms and constellation diagrams.	6
	c	Discuss the various Multiple Access Techniques used in cellular network.	6
OR			
Q. 08	a	Describe the classification of RF (Radio Frequency) spectrum with applications in communications systems.	8
	b	Explain different types of radio wave propagation with a neat diagram.	6
	c	Write short notes on: Forward Error Correction, Automatic Repeat Request	6
Module-5 (Cellular Wireless Networks, Wireless Network Topologies, Satellite Communication, Optical Fiber Communication, Microwave Communication)			
Q. 09	a	Define the terms cell & cluster in a cellular system and explain the cellular concept in wireless mobile networks.	6
	b	Discuss 3G technology with specific emphasis on CDMA.	6
	c	Bring out the features of FM transmitter, FM receiver and repeaters in microwave communications.	8
OR			
Q. 10	a	Define the following terms with respect to GSM system: Mobile Station (MS), Base Station Subsystem (BSS), Network & Switching System (NSS)	6
	b	With the help of a block diagram explain the generalized configuration of a fiber – optic communication system.	8
	c	Based on orbits, discuss the different types of satellites.	6

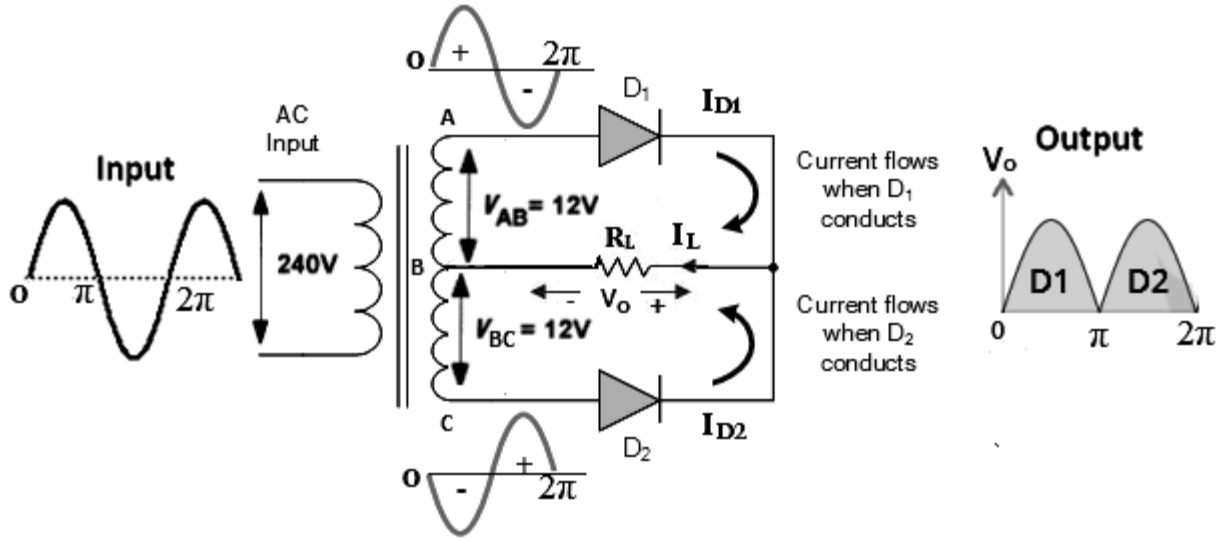
Solution for VTU Model Question paper Set-2

BASIC ELECTRONICS & COMMUNICATION ENGINEERING (21ELN14)

Module -1

1.a) Explain the working of Bi-phase Full wave rectifier circuit with neat diagram. (8Marks)

The AC mains (240V) is applied to the primary of T1 which has two identical secondary windings each providing 12V r.m.s, as shown in the fig.



On +ve half cycles, point A will be +ve with respect to point B. similarly, point B will be +ve with respect to point C.

D1 will forward bias, acts like a closed switch hence conducts. While D2 will reverse bias, acts like an open switch hence do not conduct. It is as shown in the fig. 9(a).

Thus, D1 alone conducts on +ve half cycles.

On -ve half cycles, point C will be +ve with respect to point B. similarly, point B will be +ve with respect to point A.

D2 will forward bias, acts like a closed switch hence conducts. While, D1 will reverse bias, acts like an open switch hence do not conduct. It is as shown in the fig. 9(b).

Thus, D2 alone conducts on -ve half cycles.

1. b) List and describe the main types of amplifiers. (7 marks)

Amplifier is an electronic circuit which increases the amplitude of its input signal without changing other parameters.

AC coupled amplifiers: In AC coupled amplifiers, stages are coupled together in such a way that DC levels are blocked and only the AC components of a signal are transferred from stage to stage.

DC coupled amplifiers: In this case, stages are coupled together in such a way that stages are not isolated to DC potentials. Both AC and DC signal components are transferred from stage to stage.

Large-signal amplifiers: Large-signal amplifiers are designed to cater for appreciable voltage and/or current levels (typically from 1 V to 100 V or more).

Small-signal amplifiers: Small-signal amplifiers are designed to cater for low-level signals (normally less than 1 V). Small-signal amplifiers have to be specially designed to combat the effects of noise.

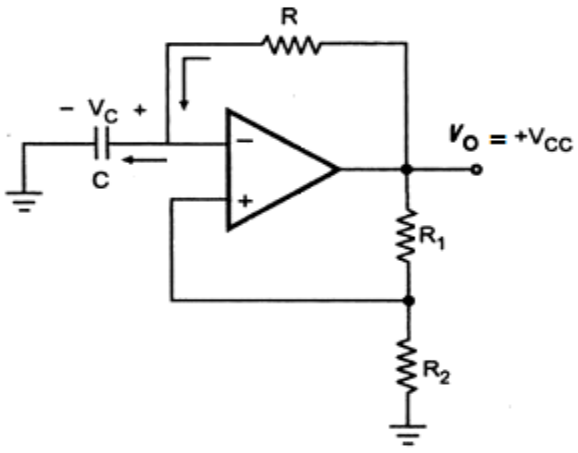
Audio frequency amplifiers: Audio frequency amplifiers operate in the band of frequencies that is normally associated with audio signals (e.g. the range of human hearing 20 Hz to 20 kHz).

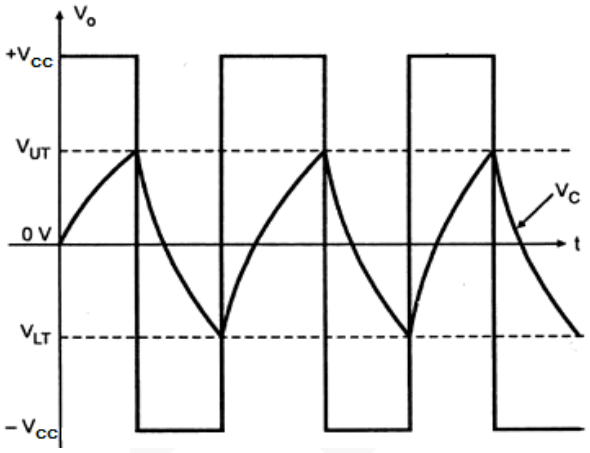
Wideband amplifiers: Wideband amplifiers are capable of amplifying a very wide range of frequencies, typically from a few tens of hertz to several megahertz.

Radio frequency amplifiers: Radio frequency amplifiers operate in the band of frequencies that is normally associated with radio signals (e.g. from 100 kHz to over 1 GHz).

1.c) Describe the working of a single stage astable oscillator using an opamp. (5 Marks)

An astable oscillator that produces a square wave output can be built using one operational amplifier, as shown in Fig. The circuit employs positive feedback with the output fed back to the non-inverting input via the potential divider formed by *R*1 and *R*2.





When $V_O = +V_{CC}$, capacitor charges towards V_{UT}

When power is turned ON, output V_O normally swings either to $+V_{cc}$ or to $-V_{cc}$.

Assume: i) *C* is initially uncharged

ii) $V_O = +V_{CC}$

The upper threshold voltage (the maximum +ve value at the inverting input) will be given by:

$$V_{UT} = V_{CC} \times \left(\frac{R2}{R1+R2}\right)$$

The lower threshold voltage (the maximum -ve value at the inverting input) will be given by:

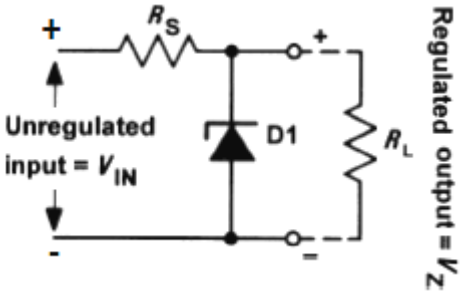
$$V_{LT} = -V_{CC} \times \left(\frac{R2}{R1+R2}\right)$$

Capacitor *C* charges through *R* and the voltage V_C rise exponentially. As voltage across the capacitor is just greater than V_{UT}, the output voltage will rapidly fall to $-V_{CC}$. Capacitor *C* will then start to discharge through R and the voltage V_C, fall exponentially. As voltage across the capacitor is slightly lesser than V_{LT}, the output voltage will rise rapidly to $+V_{CC}$. This cycle will continue indefinitely.

2.a) Explain the operation of a simple shunt Zener voltage regulator. (7Marks)

The circuit diagram of the zener diode as a simple voltage regulator is shown in the fig.

The series resistor, R_S is connected in the circuit to limit the current through the zener diode to a safe value when load R_L is disconnected. Also, the voltage drop across it is a part of unregulated input voltage, V_{in}. When R_L is connected, zener current I_Z will reduce as current ($I = I_z + I_L$) is split into load R_L.



Output voltage, remains constant until regulation fails. Regulation fails at a point at which potential divider formed by R_S and R_L produces lower voltage than V_Z voltage.

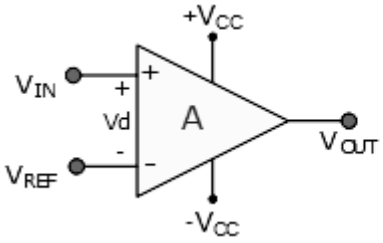
$$V_Z = V_{IN} \times \frac{R_L}{R_L + R_S}$$

Series Resistor value (ohms) = (V_i – V_z) / (Zener current + load current). Maximum value of R_S can be calculated as,

$$R_{Smax} = R_L \times \left(\frac{V_{IN}}{V_Z} - 1\right) \text{ and } R_{Smin} = \frac{(V_{IN}V_Z) - V_Z^2}{P_{Zmax}}$$

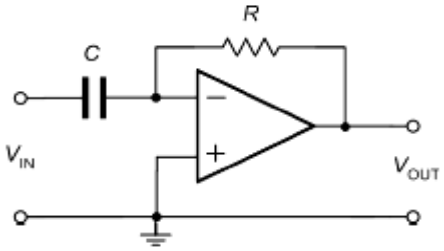
2.b) Sketch the circuit of each of the following based on the use of operationalamplifiers (a) comparator (b) a differentiator (c) an integrator (d) Inverting Amplifier. (8Marks)

Comparator compares the magnitudes of two voltage inputs and determines which is the larger of the two.



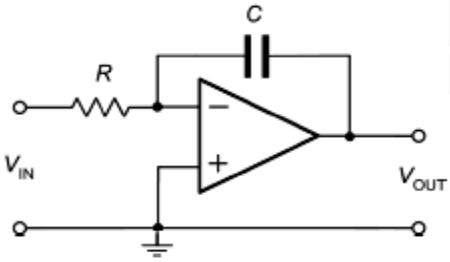
If $V_{IN} > V_{REF}$ then $V_{OUT} = +V_{CC}$
If $V_{IN} < V_{REF}$ then $V_{OUT} = -V_{CC}$

Differentiator produces output voltage (V_{out}) is proportional to the rate of change of the input voltage V_{in}.



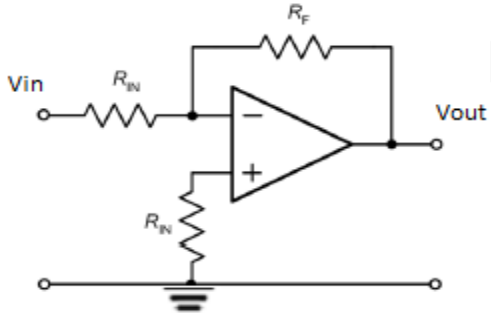
$$V_{out} = -RC\frac{d}{dt}(V_{in})$$

Integrator produces output voltage V_{out}, is proportional to the integral of the input voltage V_{in}.



$$V_{out} = -\frac{1}{CR}\int V_{in}\,dt$$

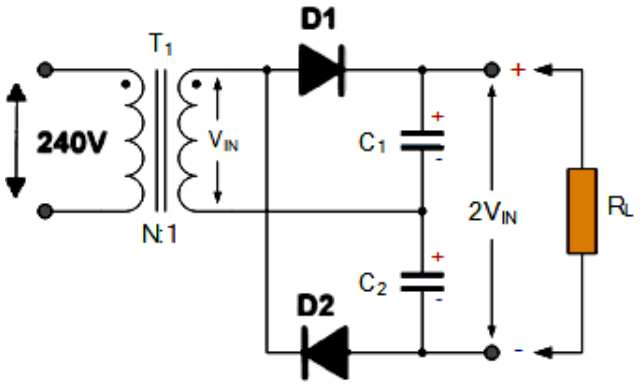
Inverting Amplifier produces output voltage V_{out} , is inverted version (180^o phase shift) of input voltage V_{in}.



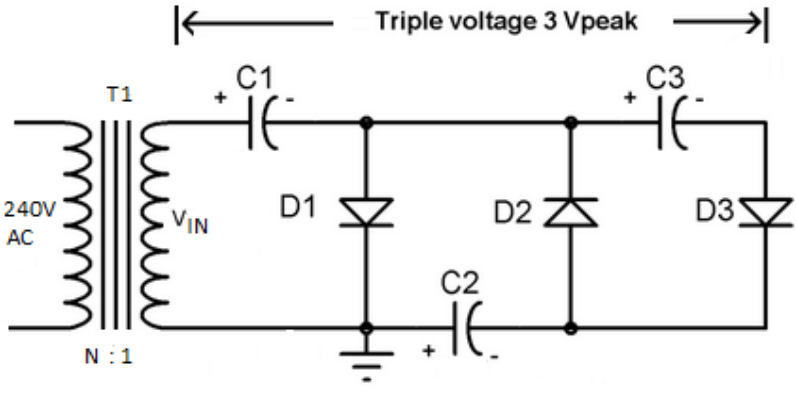
$$V_{out} = -V_{in}\left[\frac{R_F}{R_{in}}\right]$$

2.c) With circuit diagram explain the following: Voltage Doubler, Voltage Tripler. (5 Marks)

Voltage Doubler produces *twice* the output voltage that of the input voltage Vin.



Voltage Tripler produces *thrice* the output voltage that of the input voltage Vin.



With no load: the output voltage will be equal to twice the input voltage Vin (sum of voltages across capacitors C_1 and C_2. $\{V_{C1} + V_{C2} = 2\ V_{IN}\}$

With load: the output voltage < 2 V_{IN}.

$V_{out} = 2V_{IN}$ – voltages drop across diodes

With no load: the output voltage will be equal to thrice the input voltage Vin (sum of voltages across capacitors C_1 and C_3)

i.e., $V_{C1} + V_{C3} = 3V_{IN}$

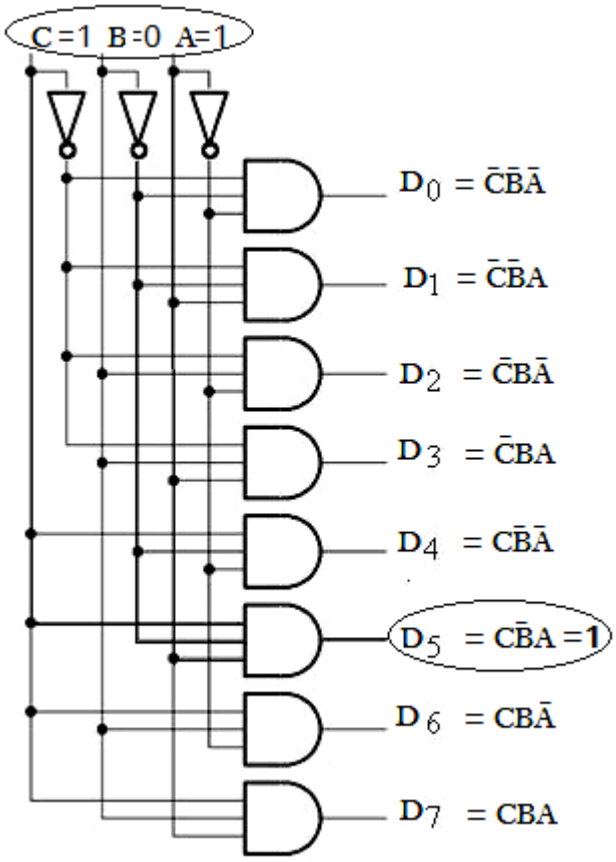
With load: the output voltage < 3 V_{IN}.

$V_{out} = 3V_{IN}$ – voltages drop across diodes

Module-2

3.a) Design a 3-to-8 Decoder and show its implementation using basic gates. (8Marks)

3 to 8 decoder has three inputs (A, B, C) and eight outputs (D_O to D_7). Based on the N = 3 inputs one of the eight ($2^3 = 8$) outputs is selected.



Truth table

Inputs			Outputs							
C	B	A	D0	D1	D2	D3	D4	D5	D6	D7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

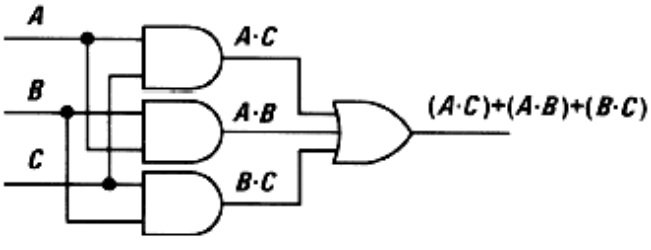
For example, if inputs C = 1, B = 0 and A = 1 is applied to above logic circuit, output D_5 =1 (see truth table). It is equivalent to D_5 =101= $C\bar{B}A$. Similarly, any one of 8 outputs from DO to D7 can be selected depending on binary status applied to 3 inputs (C, B and A).

3.b) Construct a logic circuit that will produce a Logic 1 output whenever two or more of its inputs are at Logic 1. (7Marks)

Consider three inputs A, B and C to produce a logic 1 output whenever two or more of its inputs are at logic 1. From the truth table we construct a logic circuit as shown below.

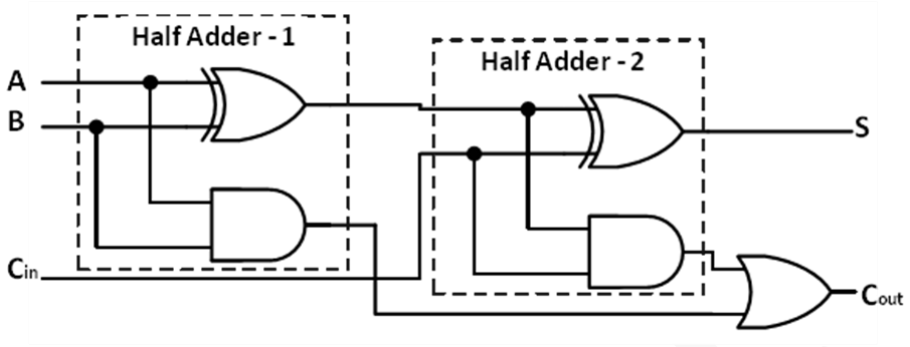
A	B	C	Y	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	1	← B·C
1	0	0	0	
1	0	1	1	← A·C
1	1	0	1	← A·B
1	1	1	1	← A·B·C

$$Y = (B\cdot C)+(A\cdot C)+(A\cdot B)+A\cdot B\cdot C$$
$$= (A\cdot C)+(A\cdot B)+(B\cdot C)$$



3.c) With the help of truth table explain full adder using logic gates. (5Marks)

Full adder circuit consists of three inputs (A, B and Cin) and two outputs (S and Cout). It adds these three input bits at a time and produce a carry (C) and sum (S). This process follows the binary addition rules. Circuit can be constructed using two half adders where it consists 2 ANDs, 2 XORs, and one OR gate.



Inputs			Outputs	
A	**B**	**C_{in}**	**Sum (S)**	**Carry (C_{out})**
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

From the truth table it is observes that,

(i) Sum (S) output is equal to 1, when only one input is equal to1 or when all three inputs are equal to1. For this Boolean expression can be written as

$$\text{Sum} = \bar{A}\,\bar{B}\,C_{in} + \bar{A}\,B\,\bar{C}_{in} + A\,\bar{B}\,\bar{C}_{in} + A\,B\,C_{in}$$

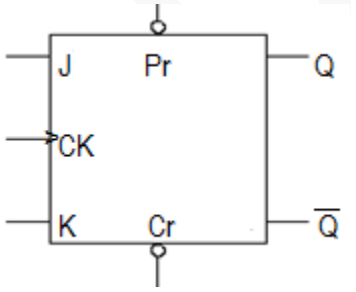
(ii) Output has a carry1, if two or three inputs are equal to1. For this Boolean expression can be written as

$$C_{out} = AB + AC_{in} + BC_{in}$$

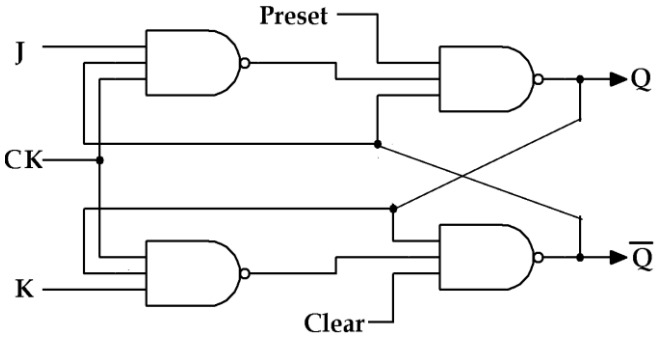
For sum and carry out Boolean expressions are given above.

4.a) Explain Input and output states for a J-K bistable using clocked operation. (8Marks)

J-K bistables have two clocked inputs (J and K), two direct inputs (PRESET and CLEAR), a clock (CK) input, and outputs (Q and $\bar{Q}$). PRESET input is used to directly put logic 1 at Q output. CLEAR input is used to directly logic 0 at Q output on the JK Flip-Flop.



Block diagram of JK Bistable



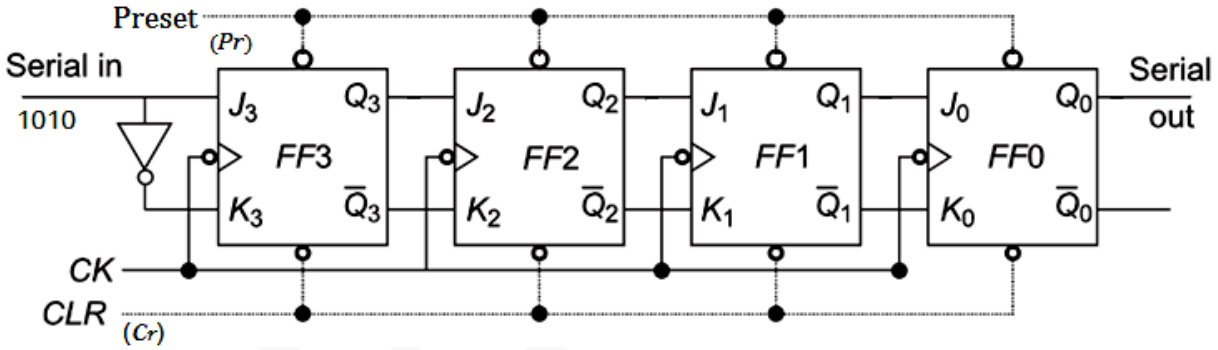
- When Preset input is 0, the output Q is set to 1, independent of clock pulse.
- When Clear input is 0, the output Q is reset to 0, independent of clock pulse.
- If both preset and clear is 0 at the same time, the output Q of flip flop states becomes independent of input clock, CK.

Preset (Pr)	Clear (Cr)	Clock (CK)	J	K	Output	comments
0	0	X	X	X	Q	Intermediate
0	1	X	X	X	Q = 0	Q changes to 0 (reset) regardless of the clock state
1	0	X	X	X	Q = 1	Q changes to 1 (set) regardless of the clock state
1	1	↑	0	0	Q	No change in state of the Q
		↑	1	0	1	Q output changes to 1 (i.e. Q is set)
		↑	0	1	0	Q output changes to 0 (i.e. Q is reset)
		↑	1	1	$\overline{Q}$	Q output changes to the opposite state

- In order for controlling J and K inputs through the clock, the CLEAR and PRESET inputs must be at logic 1.

4.b) With the help of a neat diagram explain the 4-bit shift register operation and types. (7 Marks)

Shift Register: It is a sequential circuit is used to *store* and *transfer* of binary data.
From the figure, all flip-flops are cleared, by making clear (CLR) = 0. During normal operation CLR =1. Also, make preset Pr = 0, to avoid interference between normal operation. All flip-flops are triggered by common clock pulse (CK). During each clock pulse, one bit of input data is transmitted from FF3 to FF0.



For example, input data (1010) has to be shifted through the register from FF3 to FF0. LSB (0) is passed first and MSB (1) is passed last to FF3.

After first clock pulse: Q_3 = **0,** Q_2 = 0, Q_1 = 0, Q_0 = 0
LSB (0) is entered into FF3 (as given function table), hence the output of FF3 is Q_3 = **0**.

After 2 clock pulses: Q_3 = **1**, Q_2 = **0,** Q_1 = 0, Q_0 = 0
Data **0** from Q_3 is shifted to FF2**,** and its output Q_2 = **0,** while **1** from input data is entered into FF3, and its output Q_3 = **1**.

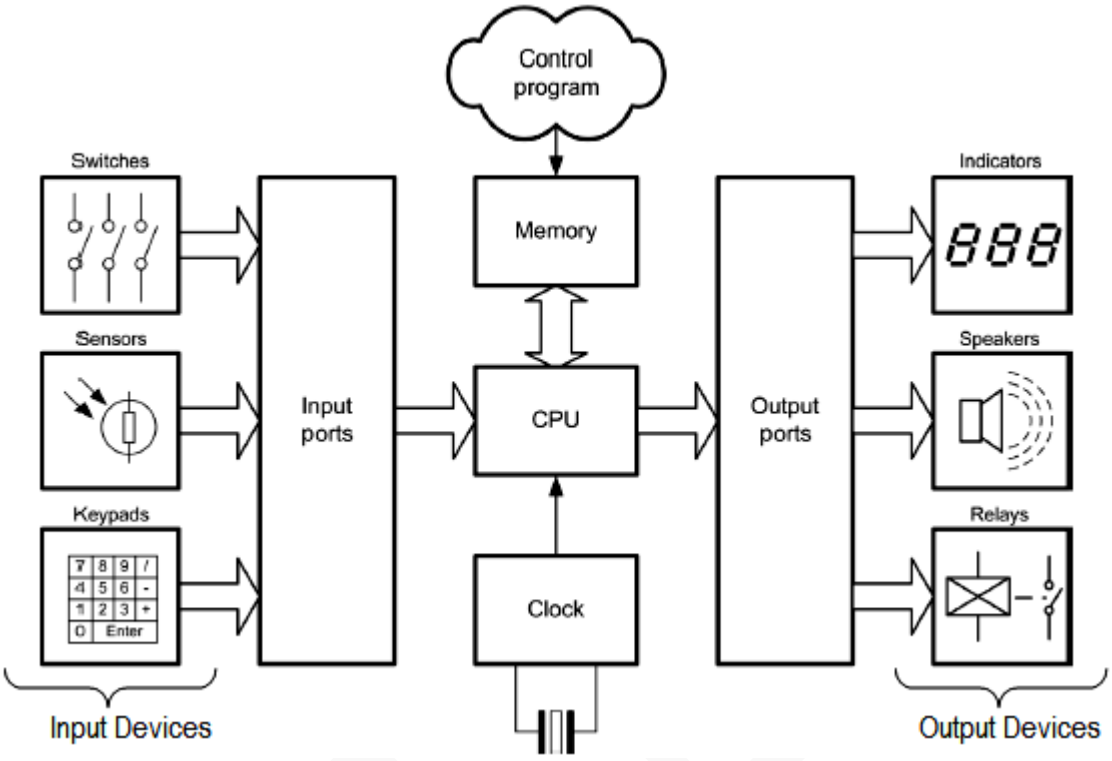
Similarly, when we apply clock pulses after 4 clock pulses: Q_3 = **1**, Q_2 = **0**, Q_1 = **1**, Q_0 = **0**
Data **0** from Q_1 is shifted to FF0**,** and its output Q_0 = **0,** data **1** from Q_2 is shifted to FF1**,** and its output Q_1 = **1** and data **0** from Q_3 is shifted to FF2**,** and its output Q_2 = **0,** while **1** from input data is entered into FF3, and its output Q_3 = **1**.

Clock Pulse	Serial In	Q_3	Q_2	Q_1	Q_0 (Serial Out)
↑	**1010**	**0**	0	0	0
↑	**101**	**1**	**0**	0	0
↑	**10**	**0**	**1**	**0**	0
↑	**1**	**1**	**0**	**1**	**0**
↑	0	0	**1**	**0**	**1**
↑	0	0	0	**1**	**0**
↑	0	0	0	0	**1**
↑	0	0	0	0	0

Types of shift registers : 1. Serial in Serial out Shift Register, 2. Serial in parallel out Shift Register
3. Parallel in Serial out Shift Register & 4. Parallel in Parallel out Shift Register

4.c) With a neat block diagram explain the arrangement of a microcontrollersystem with typical inputs and outputs. (5Marks)

Microcontroller is a programmable device consists of a central processing unit (CPU), memory, peripherals, and support circuitry on a single chip. The block diagram of microcontroller system is shown in figure.



CPU: It is the main component of the processor that contains Arithmetic Logic Unit (ALU) and Control Unit (CU). It control and manages all processes that are carried out in the microcontroller unit. It also communicates devices like memory, input ports, output ports and clock unit.

Control Program: The operation of the microcontroller is controlled by a sequence of software instructions known as a control program that examining inputs from input devices and output signals sent to controlled devices.

Input devices: Input ports are mainly used to communicate with various input devices such as switches, sensors and keypads. Sensors convert physical quantities (temperature, position, etc.) into corresponding electrical signals.

Output devices: Output ports are mainly used to communicate with various output devices such as LED indicators, printers, speakers, relays, motors, etc. Output devices are used to convey information to the outside world.

Module-3

5.a) Compare Embedded systems and general computing systems. Also provide major application areas of Embedded Systems. (8Marks)

General Computing System	Embedded Systems
It is microprocessor based system	It is microcontroller based system
It needs human interaction to perform tasks.	Does not need human interaction to perform tasks.
Architecture examples: Analog / Digital computer, Hybrid computer, Harvard /Von Neumann architecture, RISC	**Architecture examples**: Small Scale Embedded System, Medium Scale Embedded Systems, Sophisticated or Complex Embedded Systems

It has 2 parts: Hardware and Software.	It has 3 parts: Hardware, Firmware and Software.
It can perform many tasks.	It performs specific tasks
Power consumption is high	Power consumption is less

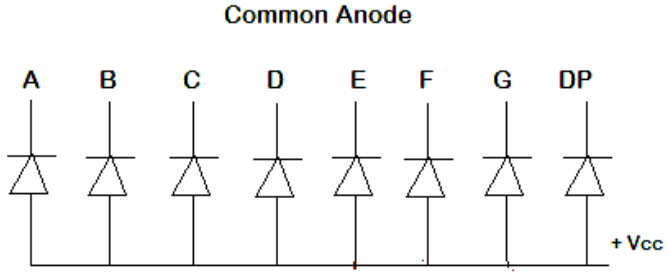
Application Areas

1. **Consumer Electronics**: Cam-corders, Digital Cameras, Laptop, CCTV etc.
2. **Household Appliances**: Television, Washing machine, Fridge, Microwave Oven etc.
3. **Home Automation and Security Systems**: Air conditioners, sprinklers, Fire alarms etc.
4. **Automotive Industry**: Anti-lock breaking systems (ABS), Engine Control, Ignition Systems, Automatic Navigation Systems etc.
5. **Telecom**: Cellular Telephones, Telephone switches, etc.
6. **Computer Peripherals**: Printers, Scanners, Fax machines etc.
7. **Computer Networking Systems**: Network Routers, Switches, Hubs etc.
8. **Health Care**: X-ray, Scanners, EEG, ECG, BP monitor, pulse monitor etc.

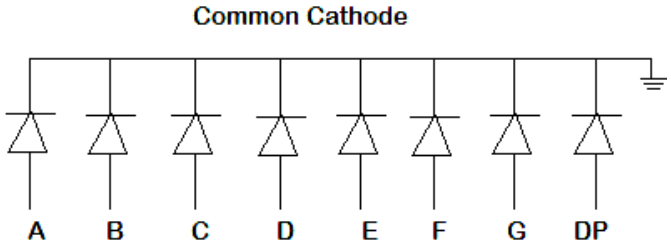
5.b) Explain the different configurations of 7-segment LED Display. (6Marks)

The 7 – segment LED displays are available in two different configurations:

i) *common anode configuration*, the anodes of all LEDs connected together to +Vcc and control signals are applied to cathodes, as shown in the figure



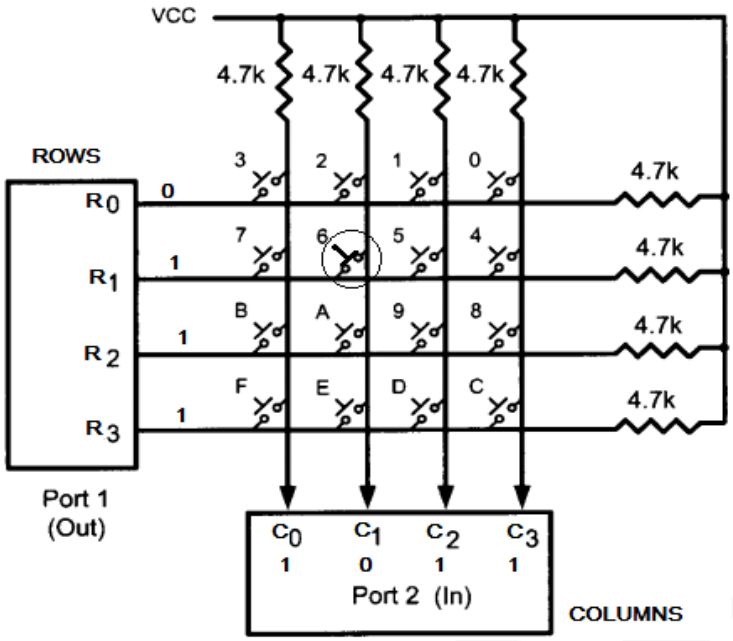
ii) *common cathode configuration*, the cathodes of all LEDs connected together to ground and control signals are applied to anodes as shown in the figure



5.c) Describe the matrix keyboard interfacing and UART. (6marks)

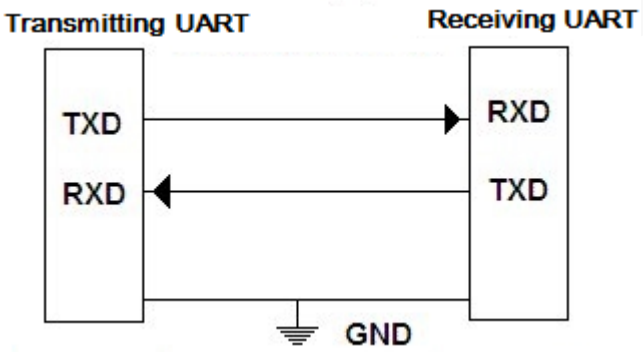
Matrix keyboard interfacing

- Keyboard is an input device for user interfacing.
- Matrix keyboard connects the keys in a row-column fashion.
- When a key is pressed, a row and a column make a contact. Otherwise, there is no connection between rows and columns.
- The key press in matrix keyboard is identified with *row-column scanning* technique.
- Since keys are mechanical devices, there is a possibility for de-bounce issues, (multiple key press effect for a single key press). This can be prevented by hardware key de-bouncer circuits or software key de-bounce techniques.

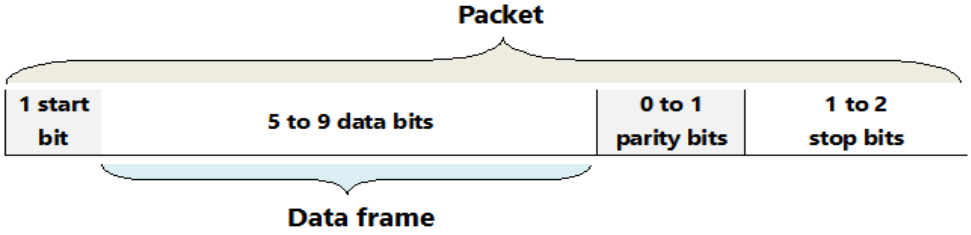


UART (Universal Asynchronous Receiver Transmitter)

In UART communication, two UARTs will communicate directly with each other. Only two wires are needed to transmit data between two UARTs. Data flows from the TXD pin of the transmitting UART to the RXD pin of the receiving UART and vice versa, as shown in the figure.



UART data transmission has no clock signal to send/receive information. Instead of a clock signal, the transmitting UART consists *start* and *stop* bits with the *data packet* being transferred.



Start bit: The UART data transmission line is normally held at *logic-1* when it's not transmitting data. To start the transfer of data, UART pulls the transmission line from *logic-1* to *logic-0.*

Data Frame: The data frame contains the actual data being transferred. It can be 5 bits up to 8 bits long.

Parity bit: It counts the number of 1's and checks if the total is an even or odd number. If the parity bit = 0 (even parity), otherwise odd parity.

Stop Bits: To indicate the end of the data packet.

6.a) Define 'sensors' and give its classification with examples. (6 Marks)

A sensor is a transducer which converts energy from physical form to electrical form for any measurement or control purpose. Sensors act as input device.

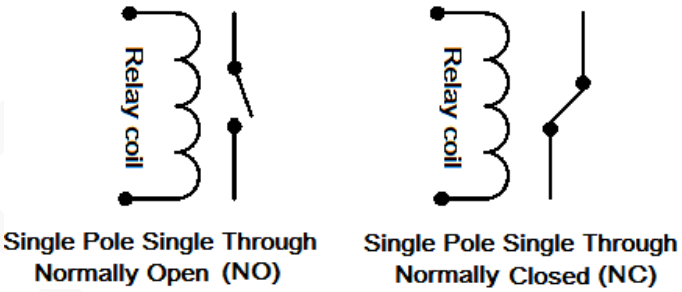
Classification of sensors:

1. Active Sensors Example: Thermocouple, Photodiode, Piezoelectric sensor.
2. Passive Sensors Example : Strain gauge.
3. Contact type*:* A sensor that requires physical contact with the parameter to be measured.
   Example: Strain gauges, temperature sensors.
4. Non-contact type*:* It requires no physical contact.
   Example: Optical sensors, Magnetic sensors, Infrared thermometer.
5. Analog and Digital Sensors Example: accelerometers
6. Absolute and Relative Sensors
7. Based on the Physical Parameter being measured Example: Flow, Level, Temperature, Pressure, etc.

6.b) With relevant diagrams explain the operation of relay, push button and piezo-buzzer. (8Marks)

Relay: An electro mechanical device which acts as a dynamic path selector for signals and power. Relay works on *electromagnetic* principle.

When a voltage is applied to the relay coil, current flows through the coil, which in turn generates a magnetic field. The magnetic field attracts the armature core and moves the contact point. The movement of the contact point changes the path of power/signal.



Single Pole Single Through Normally Open (NO)

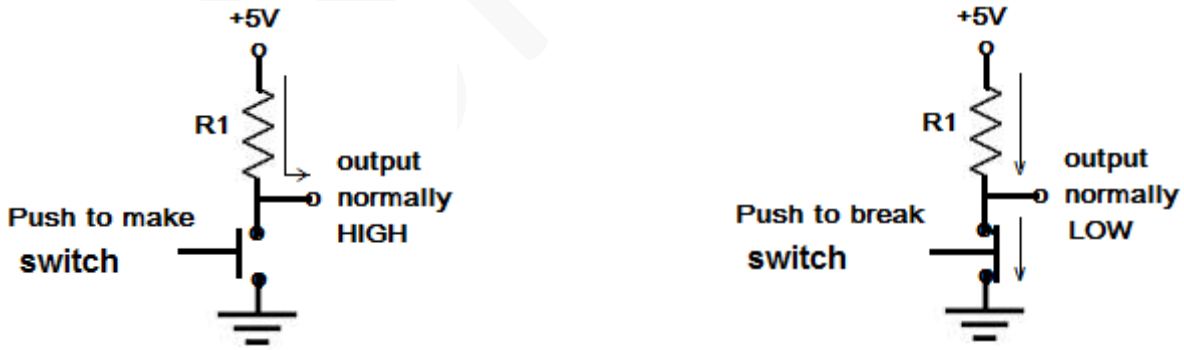
Single Pole Single Through Normally Closed (NC)

Push Button: It is a basic input device used to control the operation of any output device using the microcontroller / control unit. Push button is used for generating a momentary pulse.

Push button switch comes in two configurations:

1. Push to Make : the switch is *normally in the open state* and makes a circuit contact when it is pushed or pressed.

2. Push to Break, the switch *normally in the closed state* and breaks the circuit contact when it is pushed or pressed.



Piezo-buzzer: It is a piezoelectric device for generating audio indications in embedded applications. A Piezo buzzer contains a piezoelectric diaphragm which produces audible sound in response to the voltage applied to it. Buzzer can be used as an alarm or as a fire alarm or as an intruder alarm.

When AC voltage is applied to the piezo-ceramic element, that extends and shrinks diametrically. This characteristic of piezoelectric material is utilized to make the ceramic plate vibrate rapidly to generate sound waves.

Piezoelectric buzzers are available in two types:

1. **Self-driving and 2. External driving**

External driving piezo buzzers supports the generation of different tones.

6.c) Explain the following external communication interfaces: USB, wi-fi (6Marks)

Universal Serial Bus (USB) is a wired high speed serial bus for data communication that enables universal communication between the peripheral devices and a host controller. The USB host controller is responsible for controlling the data communication, including establishing connectivity with USB slave devices, packetizing and formatting the data packet.

USB 2.0 cable

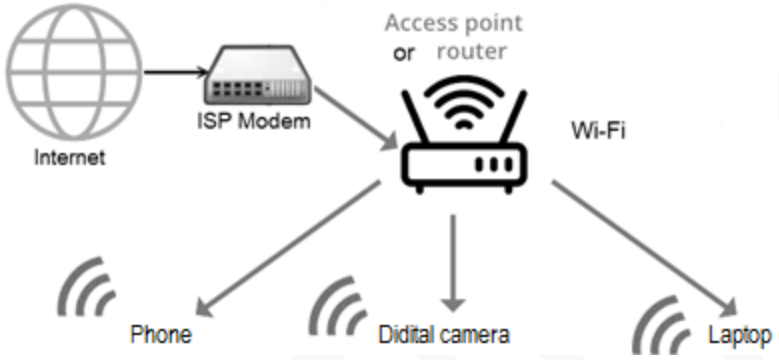
For example, USB 2.0 cable, has four shielded wires.

Red wire (1) for power supply voltage (+5V) and black wire (4) for ground that allow the device to be powered by the host through the USB connection. The other two wires, green wire (3) is for the data (D+) upstream and white wire (2) is for data (D-) downstream are responsible for the transmission of the data.

Pin	Name	Cable color	Description
1	VCC	Red	+5 VDC
2	D-	White	Data -
3	D+	Green	Data +
4	GND	Black	Ground

The USB cable supports communication distance of up to 5 meters.

Wi-Fi is a wireless high-speed internet connection technique used to connect computers, tablets, smart phones and other accessing devices. Wi-Fi uses radio waves sent from a wireless *router* to a nearby device, which translates the signal into a data format. Wi-Fi connection is established from the *access point* to the Wi-Fi enabled devices within a specific range as shown in the figure. There are four major types of Wi-Fi standards, operate in wide range of data speed and transmits on 2.4GHz or 5GHz frequency.



Wi-Fi standards	Transmitting frequency	Data speed
IEEE802.11b	2.4GHz	11Mbps
IEEE802.11a	5GHz	54Mbps
IEEE802.11g	2.4GHz	100Mbps
IEEE802.11n	2.4GHz/5.0GHz	600Mbps

Module-4

7.a) Define and explain SNR, Noise Figure, channel types, amplitude modulation. (8 Marks)

Signal to Noise Ratio (*SNR*) is defined as the ratio of signal power (S) to the noise power (N), expressed in (dB).

$$SNR = \frac{P_{signal}\ \text{(Wanted component)}}{P_{noise}\ \text{(Unwanted component)}} = \frac{P_s}{P_n} = \frac{V_s^2/R}{V_n^2/R}$$

$$\left(\frac{S}{N}\right)_{dB} = 10\log_{10}\left(\frac{V_s^2}{V_n^2}\right)$$

$$\left(\frac{S}{N}\right)_{dB} = 20\log_{10}\left(\frac{V_s}{V_n}\right)$$

Noise Figure, *NF* $= 10\log\frac{\text{Input SNR}}{\text{Output SNR}}$ (dB)

Channel Types: Channel means the medium through which the message travels from the transmitter to the receiver. Mainly there are two types:

1. **Hardwired channels** (Manmade structure)

i) Twisted pair cables used in telephony, in which two conductors are twisted together.

ii) Coaxial cable used in TV transmission, to carry high-frequency electrical signals with low losses.

iii) Waveguide: consisting of a hollow, metal tube of uniform cross-section used for transmitting electro-magnetic waves.

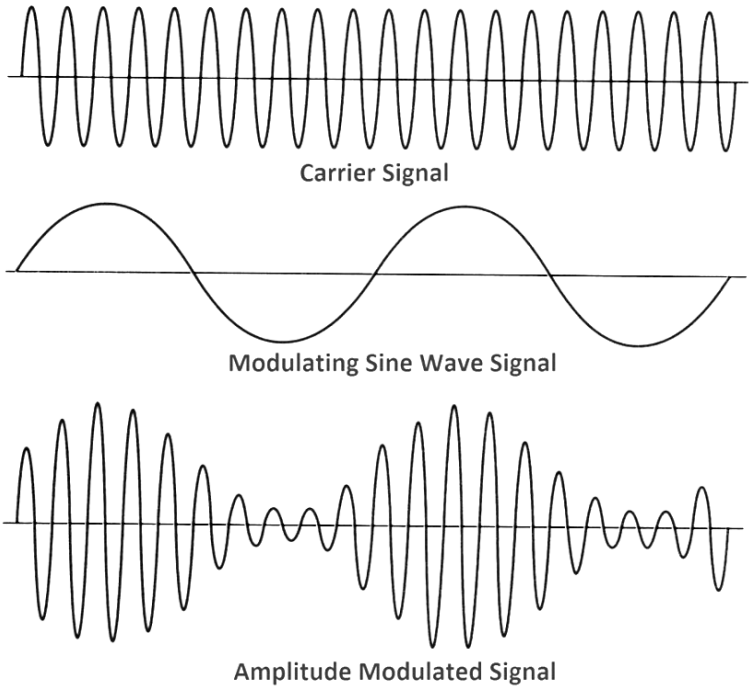
iv) Optical Fibre: consist of very thin hollow glass fibre through which the signal is transmitted in the form of light energy.

2. **Soft-wired channels** (no physical link between transmitter and receiver)

Natural resources air or water can be used as the transmission medium for signals.

Example**:** Radio signals in open space and Sea water.

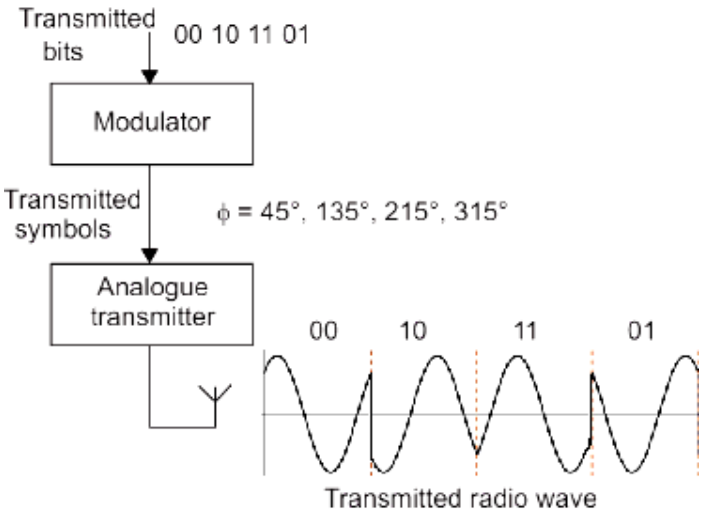
Amplitude Modulation (AM): It is the process in which the amplitude of the carrier signal is varied according to the instantaneous values of the message signal, where as the frequency and phase are kept constant. It is as shown in the fig.



7.b) Present the architecture of a wireless communication transmitter and its modulation scheme QPSK with waveforms and constellation diagrams. (6Marks)

From the fig. the wireless transmitter accepts four different binary streams of bits (00, 10, 11 and 01) from the application software. Further, these bits encoded on to a radio wave, known as a carrier by adjusting its amplitude or phase.

Transmitter operates in two stages. In the *first stage*, quadrature phase shift keying (QPSK) modulator accepts the incoming binary bits and convert it to symbols that represents the amplitude and the phase. In the *second stage*, the symbols are passed over the analog transmitter, which generates the radio wave.



QPSK modulator takes two bits at a time and transmits them using a radio wave. Four different binary states have phases of 45^o, 135^o, 225^o, and 315^o as shown in the fig.2(a) and constellation diagrams shown in fig.2(b).

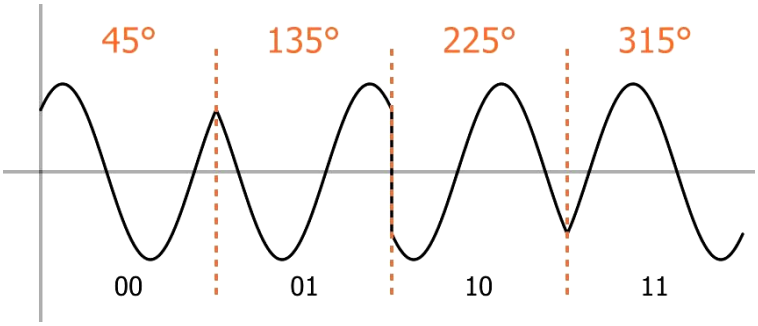
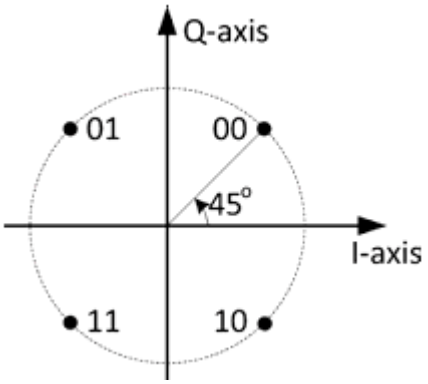


Fig.2 (a) QPSK representation



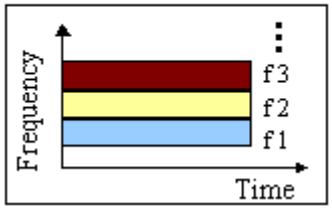
(b) QPSK constellation diagram

7.c) Discuss the various Multiple Access Techniques used in cellular network. (6Marks)

Multiple access is a techniques to provide communication service to multiple users over a single channel. It allows multiple mobile users share the allotted spectrum in the most effective manner.

Frequency Division Multiple Access

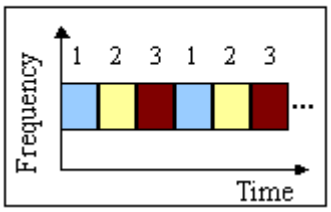
Available frequency band is split into smaller frequency channels, and different channels are assigned to different users. The carriers are separated by guard bands, which avoid the interference between the users.



Time Division Multiple Access

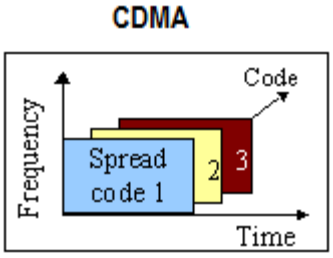
Every user is permitted to transmit in the same frequency band at different time slots.

The carriers are separated by guard bands, which avoid the interference between the users.



Code Division Multiple Access

Signals are transmitted on the same carrier frequency and at the same time. But the signals are labeled by the use of codes, which allows a mobile to separate its own signal from the others.



8.a) Describe the classification of RF (Radio Frequency) spectrum withapplications in communications systems. (8Marks)

Frequency ranges and its application in communication systems

Frequency Name	Radio Frequency Range	Application in communication systems
Super high frequencies	3GHz-30GHz	RADAR
Ultra high frequencies	300MHz-3GHz	Satellite communication, cellular phones
Very high frequencies	30MHz-300MHz	TV and FM
High frequencies	3MHz-30MHz	Commercial short wave broadcast
Medium frequencies	300kHz-3MHz	AM broadcast
Low frequencies	30kHz-300kHz	Navigation, submarine communication
Very low frequencies	3kHz-30kHz	Navigation, submarine communication
Voice frequencies	300Hz-3kHz	Navigation ,submarine, audio
Extremely low frequencies	30Hz-300Hz	Power transmission

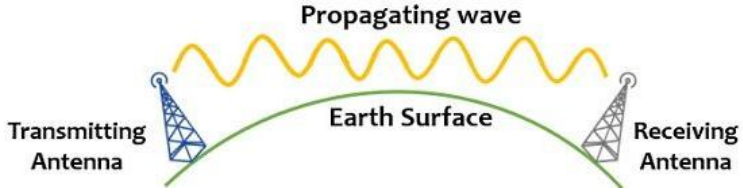
8.b) Explain different types of radio wave propagation with a neat diagram. (6Marks)

Radio waves exhibit the properties of light with the velocity $3x10^8$ m/s. These are electromagnetic (EM) waves that consist of electric and magnetic field components. It is traversed in nature.

Radio propagation is the way of transmitting radio signals in different ways:

i) Ground or surface wave

Ground waves can be used for radio communication**.** Ground wave transmission is very reliable irrespective of the atmospheric conditions.



Frequency range: 30 kHz to 3 MHz
Transmission distance: 100 to 1000 km

Example: AM radio broadcast in the medium frequency band cover local areas.

ii) Space wave

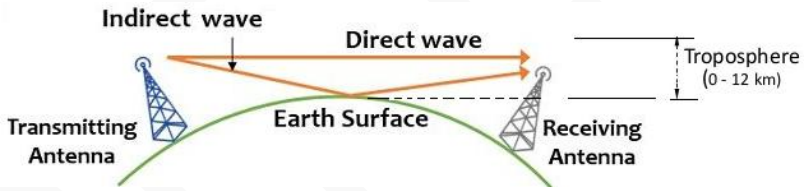
In space wave (or line of sight propagation), radio waves move in the earth's troposphere within about 12 KM over the surface of the earth. *Frequency range*: 3MHz to 30 MHz.

Example, TV Transmission.

The space wave is made up of two components:

(a) a *direct or line-of- sight wave* from the transmitting *to* the receiving antenna and

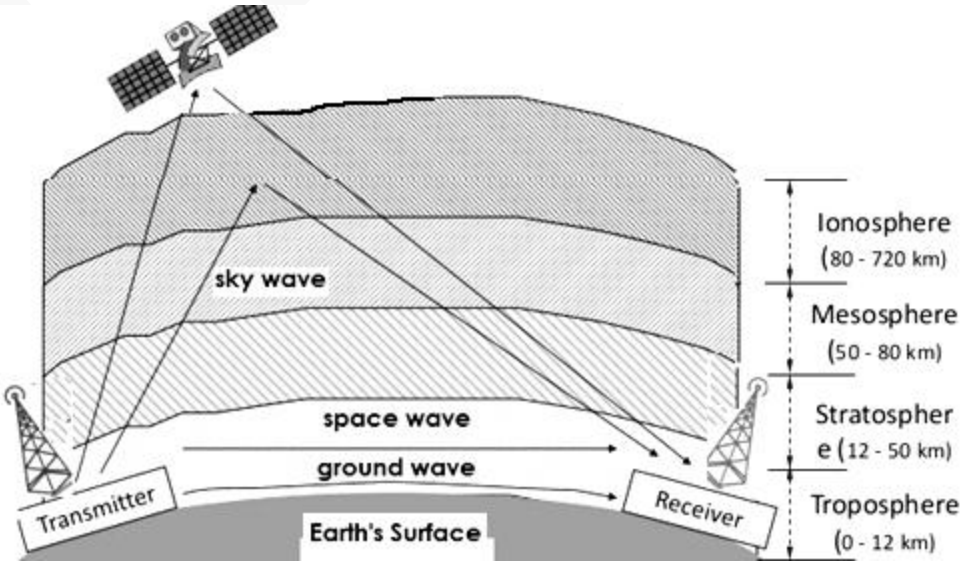
(b) an *indirect or ground-reflected* wave traversing form the transmitting antenna to ground and reflected to the receiving antenna.



iii) Sky wave

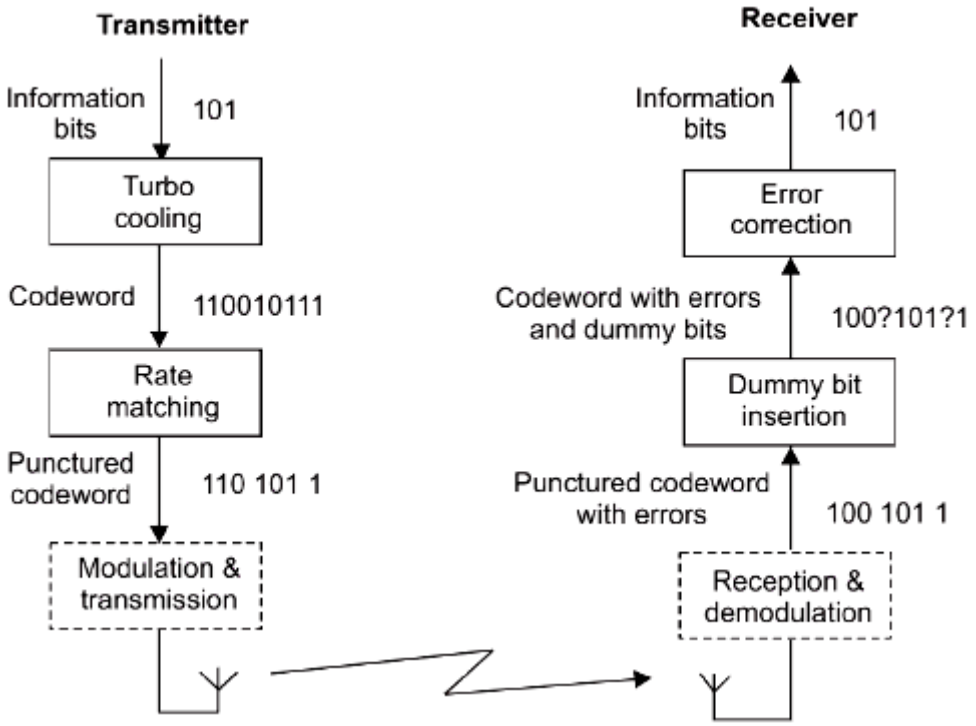
Sky wave (the earth's upper atmosphere) is responsible for short wave transmission around the globe via successive reflections at the ionosphere and the earth's surface.

Ionosphere - The ionized region extending about 80 KM above the earth's surface. In ionosphere radiation from the sun ionizes atoms and molecules that liberate electrons and ions from molecules. The propagation of radio wave through the ionosphere is affected by the electrons and ions.



8.c) Write short notes on: Forward Error Correction, Automatic Repeat Request. (6 Marks)

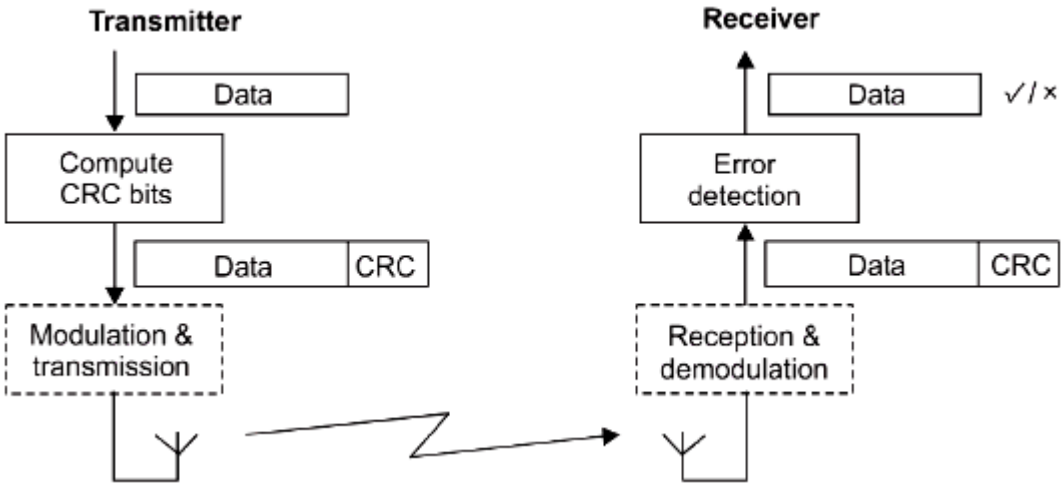
Forward error correction – It is technique used for controlling errors in data transmission over unreliable or noisy communication channels. The transmitted information is represented using a codeword that is typically two or three times as long. The extra bits supply additional, redundant data that allow the receiver to recover the original information sequence.



For example, a transmitter might represent the information sequence 101 (3-bits) using the codeword 1**1**0010111 (9-bits). After an error in the second bit, the receiver might recover the codeword 1**0**0010111. If the coding scheme has been well designed, then the receiver can conclude that this is not a valid codeword, and that the most likely transmitted codeword was 110010111.

Automatic Repeat Request

Automatic repeat request (ARQ) is another error management technique, which is illustrated in fig.



Transmitter takes a block of information bits and uses them to compute some extra bits that are known as a cyclic redundancy check (CRC).

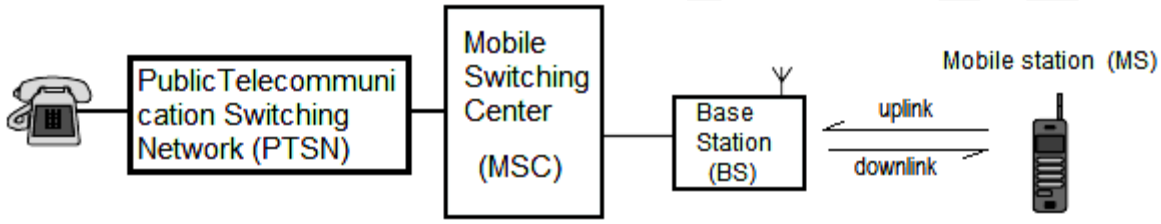
It appends these to the information block and then transmits the two sets of data in the usual way. Receiver separates the two fields and uses the information bits to compute the expected CRC bits.

If the observed and the expected CRC bits are the same, then it concludes that the information has been received correctly and sends positive acknowledge back to the transmitter.
If CRC bits are the different, then it concludes that the error has occurred and sends negative acknowledge back to the transmitter to request retransmission. Positive and negative acknowledgements are often abbreviated to ACK and NACK respectively.

Module-5

9.a) Define the terms cell & cluster in a cellular system and explain the cellular concept in wireless mobile networks. (6 Marks)

Cell: A basic geographical service area (5-20kms) of a cellular communication system. Each cell is allocated a band of frequencies and is served by a base station.
Cluster: The groups of cells are known as *clusters*, in which no frequency is reused within a cluster.
Concept of wireless mobile network: In a cellular system, as shown in the fig., hand-sets carried by the users is called Mobile Stations (MS). The MS communicate to the Base Stations (BS) through a pair of frequency channels, one for *up-link* and another for *down-link*. All the BS of cellular systems are controlled by a central switching station called Mobile Switching Center (MSC).



The MSC is responsible for all kinds of network management functions such as channel allocations, handoffs, handover, billing, power control etc. The MSC can route voice calls through the public switched telephone network (PSTN) and it can also provide internet access.

9.b) Discuss 3G technology with specific emphasis on CDMA. (6Marks)

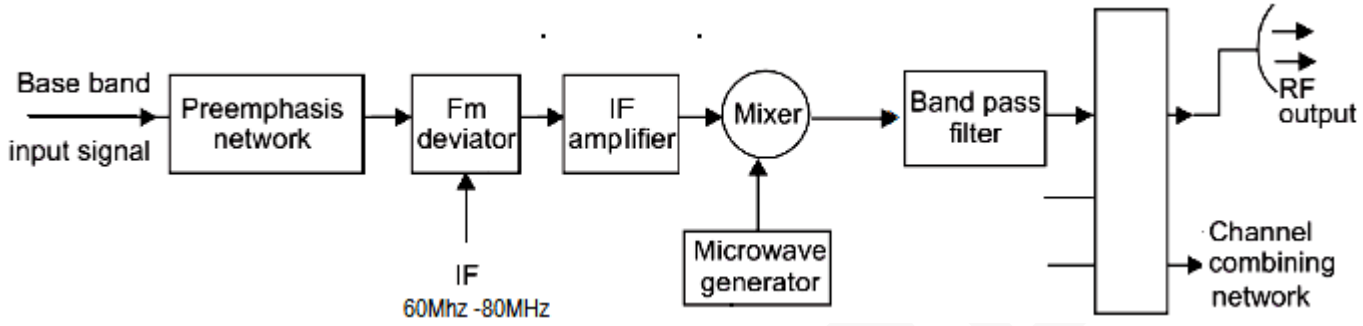
- 3G is the upgrade over 2G, 2.5G, GPRS and 2.75G EDGE networks (family of standards).
- 3G offers faster data transfer, and better voice quality, with high speed packet switched data (up to 2 Mbps). In this generation smart phones are introduced.
- Allow both digital data and voice communication.
- To facilitate universal personnel communication, listen music, watch movie, access internet, video conference, universal global roaming, etc.
- The dominant technology for 3G systems is CDMA.
- Code Division Multiple Access system is very different from time and frequency multiplexing. It optimizes the use of available bandwidth and supports high speed packet switched data.
- The technology is commonly used in ultra-high-frequency (UHF) cellular telephone systems, bands ranging between the 800-MHz and 1.9-GHz.
- Capacity of a Mobile Telecommunication System is given by
  Channel capacity, $C = B\ log_2(1 + SINR)$
  SINR = Signal to (Interference + Noise) Ratio,
  B = bandwidth of communication system
- CDMA offers these advantages: Error Control Coding, Spreading of the spectrum, Soft handoffs, Strict power control.

9.c) Bring out the features of FM transmitter, FM receiver and repeaters inmicrowave communications. (8Marks)

FM microwave communication system provides flexible, reliable and economical point to point communication.

FM transmitter

Baseband input signal: It can be FDM voice channel, TDM channel, composite video signal, or wideband data signal applied to pre-emphasis network as input.



Pre-emphasis network: It provides extra amplification to high frequency baseband signals.

FM deviator: It provides the modulation. At this stage low frequencies get frequency modulated by the IF range (60-80MHz) signal and high frequencies get phase modulated.

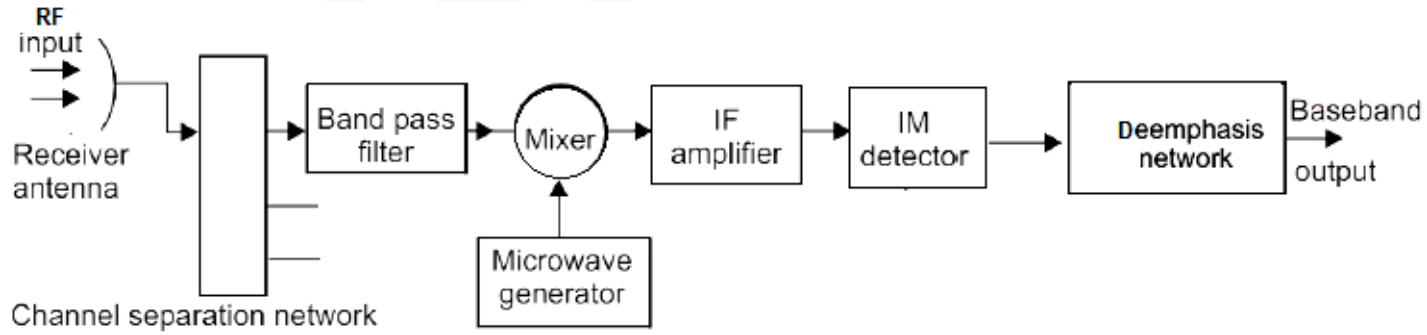
IF amplifier: Output of FM deviator is amplified by the IF amplifier and it is passed to mixer circuit.

Mixer: It converts IF signal into RF microwave frequencies. The mixer preserves modulation index and limits the bandwidth.

Band pass filter: The output of the mixer is passed through the band pass filter to band limit the signal and then to channel combining network that separates individual channels. Finally, the signal is fed to transmitter antenna.

FM Microwave Receiver:

In the FM microwave receiver as shown in the below fig., the RF signal is picked by antenna and passed to the channel separation network that provides the separation of individual microwave channels and directs them to their respective receivers.



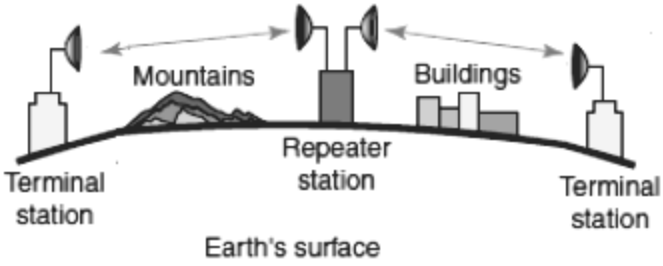
Band-pass filter: It filters any signal falling outside the bandwidth of the required signal and passed to the mixer.

Mixer: Mixer translates (down-convert) the RF microwave frequencies to IF frequencies and pass them on to the FM demodulator.

FM detector: It is an FM demodulator that separates baseband signal from IF band. The output of the IM detector is applied to a de-emphasis network.

De-emphasis stage performs attenuating those frequencies by the amount by which they are boosted during pre-emphasis at the transmitter side. Finally, restores the baseband signal.

Repeaters: A *microwave repeater* is a tower equipped with a receiver and transmitter for picking up, amplifying, reshapes it and then transmits the signal to the next repeater or terminal station. Also known as microwave link; microwave relay.



When the distance is longer than 40 miles or when geographical obstructions (such as a mountain, buildings etc) block the transmission path, then *repeaters* are needed.

10.a) Define the following terms with respect to GSM system: Mobile Station (MS), Base Station Subsystem (BSS), Network & Switching System (NSS) (6Marks)

The GSM architecture consists of three major interconnected subsystems that interact with themselves and with users through certain network interface. They are Mobile Station (MS), the Base Station Subsystem (BSS) and Network Switching Subsystem (NSS).

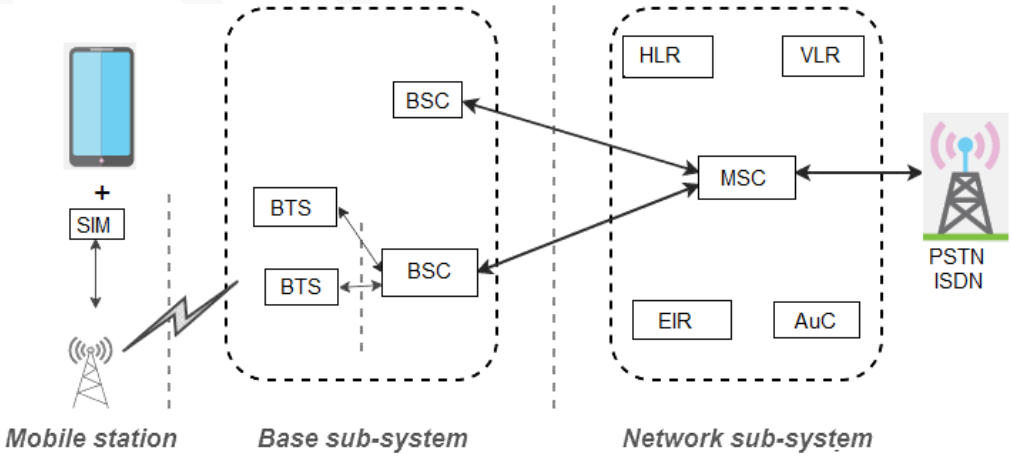
Mobile System (MS): comprises user equipment and software needed for communication with a mobile network. Mobile Station (MS) = Mobile Equipment (ME) + Subscriber Identity Module (SIM).

Base sub-system (BSS): The BSS handles traffic between the MS and the NSS. It consists of two main components: the base transceiver station (BTS) and the base station controller (BSC). The BTS contains the equipment that communicates with the mobile phones, while the BSC is to allocate necessary time slots between the BTS and MSC.

Network Sub-system (NSS): The NSS is the core network that tracks the location of callers to enable the delivery of cellular services. It includes 5 functional units.

i) Mobile switching center (MSC)**:** performs call setup, call release, call tracing, call forwarding and Short Message Service (SMS)

ii) Home location register (HLR)**:** functions the subscriber's ID, plan and caller tune you are using location, authentication via SIM cards.



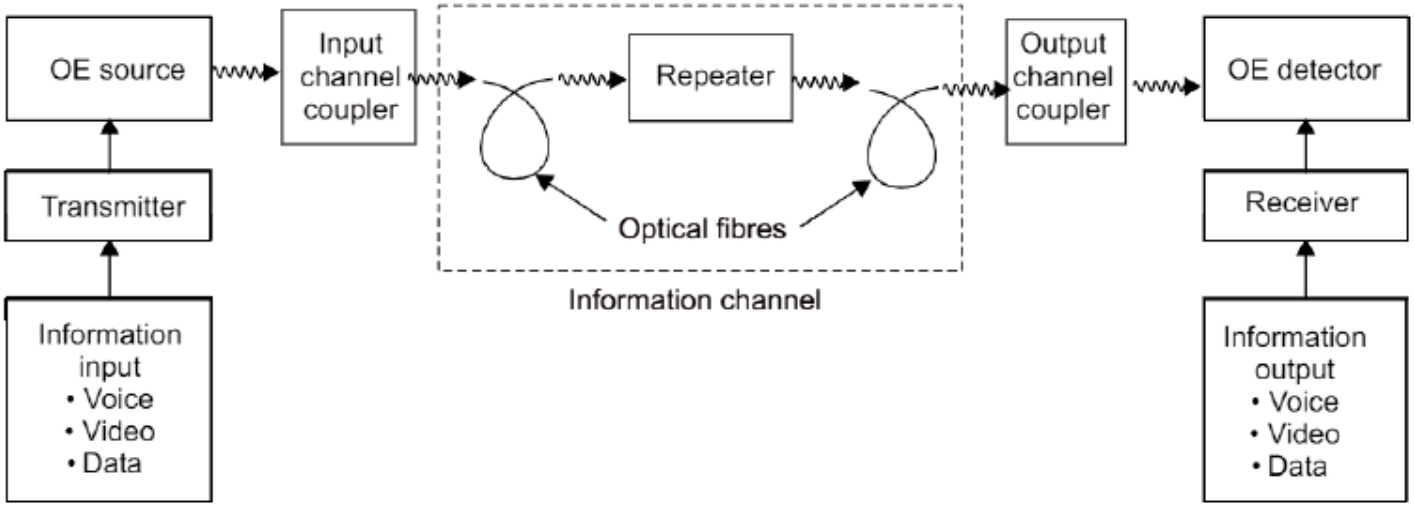
iii) Visitor location register (VLR)**:** contains the exact location of all mobile subscribers currently present in the service area of MSC

iv) Equipment identity register (EIR)**:** It is a database register which contains a list of valid mobile equipment on the network. It keeps the database record of all allowed or banned in the network.

v) Authentication center (AuC)**:** It perform authentication of subscriber.

10.b) With the help of a block diagram explain the generalized configuration of a fiber – optic communication system. (8Marks)

The generalized configuration of a fiber-optic communication system is (shown in the fig.) described as follows:



Information input: It receives information in physical forms (for example, voice, video and data) and passed over to transducer. Input transducer (sensor) converts the physical signal into electrical signal.

Transmitter (Modulator): The role of the optical transmitter is to:

- convert the electrical signal into optical form
- couple (launch) the resulting optical signal into the optical fiber

The optical transmitter consists of driver circuit and optical source which impresses the signal onto EM wave. OE source generates the EM wave (light) acts as a carrier in optical range. Common sources for fiber optic are – LED and ILD (injection laser diode).

Coupler: It collects light signal from the OE source and sends it efficiently to the optical fiber cable. Coupling losses may be large due to reflection and limited light gathering capacity of the couplers.

Information channel is an optic cable consisting of single or bundle of fibers. The optical fiber acts as a wave guide and transmits the optical pulses towards the receiver, by the principle of total internal reflection.

Repeater : After certain long distance optical signals become weak and degrade, due to scattering, absorption and dispersion. The repeater used for restoring the strength and shape of the signal.

Photo detector: This converts the optical signal to electrical signal. For this semiconductor PIN diodes or avalanche photodiodes are used. The photo current developed is proportional to the incident optical power.

Receiver: The output of the photo detector (photocurrent) is filtered to remove the dc bias. After filtering the photocurrent, it is amplified if needed. Then the receiver converts the light signal into electrical form.

10.c) Based on orbits, discuss the different types of satellites. (6Marks)

Features	Low Earth Orbit	Medium Earth Orbit	Geostationary/ geosynchronous Earth Orbit
Earth-to-orbit distance	200-2,000Kms	10,000-20,000Kms	35,786Kms
Orbital period	95-120minutes	6-12 hrs	23hr 56min 4Sec
Propagation delay	4.5msec	70-80msec	> 240msec

Application	Remote sensing Communication	Communication Navigation	Communication, Internet, Weather Forecasting
Disadvantage	1. Less area coverage 2. Short life time 3. Many satellites create orbital complexity	1. High Latency than LEO 2. Requires high transmitting power	1. High Latency than LEO /MEO 2.Requires high transmitting power 3. Requires large antenna 4. More cost of satellites