Unit III
Sound / Audio

4.1 Basic Sound Concepts:-
Sound :-

- Sound is the form of energy that travels in the form of wave.

- Sound is produced by the vibration of matter/air.

- During the vibration, pressure variations are created in the air surrounding it.

- This alteration of high and low pressure propogated through the air in a wave of motion. When the wave reaches our ears, we here a sound.

- Sound is creating by a vibrating object.

- Sound travels as a wave through a medium.

- Medium is material that carries or transport the wave form its source to other location.
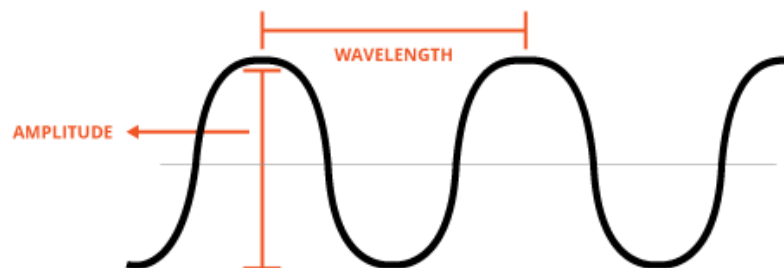
- The Pattern of the oscillation is called a wave form.

Characteristics of Sound :-
- Sound waves can be described by the five characteristics, they are –
  1. Wavelength
  2. Time-Period
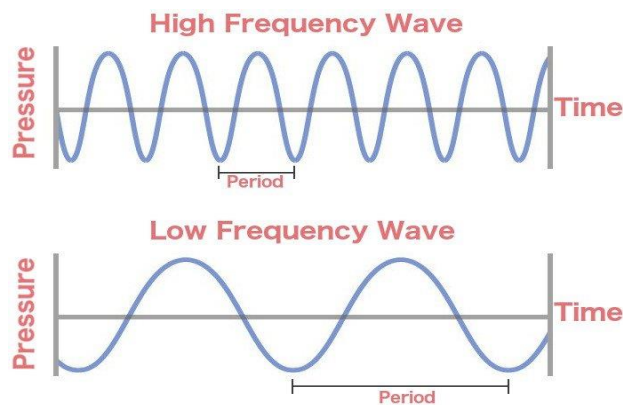 3. Frequency
  4. Amplitude
  5. Velocity

1. **Wavelength :-** The distance between peaks or highpoints is called Wavelength.

2. **Time – Period** :-
- The waveform repeat the same shape at regular interval and this portion is called a Time-Period.

3. **Frequency :-**
- Frequency is the speed of vibration.
- It is only useful for musical sounds, where there is a strongly regular waveform.

- Humans can only here sound waves, where the frequency of sound is between 20 Hz and 20 KHz.
- Sound waves above 20 KHz are known as Ultrasound. It is not acceptable by humans.
- Sound waves below 20 KHz are known as Infrasound.
- Frequency is measured as the no. of wave cycles that occur in one second.
- The unit of frequency measurement is Hertz(Hz).
- A frequency of 1 Hz means one wave cycle per second.
- A frequency of 10 Hz means ten wave cycles per second, where the cycles are much shorter and closer together.
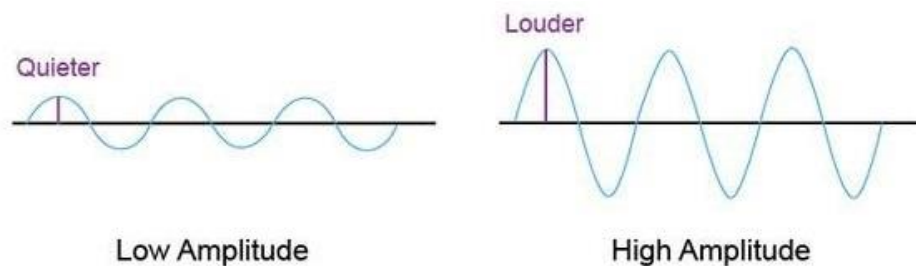- The frequency range is divided into:

Infra-sound	From 0 to 20 Hz
Human hearing frequency range	From 20Hz to 20 KHz
Ultra sound	From 20 KHz to 1 GHz

| Hyper sound	From 1 GHz to 10 THz

4. **Amplitude :-**
  - Amplitude is the size of vibration and this is determaines how loud the sound is.
  - We know that larger vibrations make a louder sound.

Low Amplitude   High Amplitude

  - Amplitude is important when balancing and controlling the loudness of sounds, such as with the volume control on your CD player.
  - It is called as Amplifier which increases the amplitude of a waveform.

4.2 MIDI:-
- MIDI stands for "Musical Instrument Digital Interface".
- It is not a instrument, it is a digital a interface between two digital devices.
- MIDI is a connectivity standard for transferring digital instrument data.
- It is primarily used by computers, synthesizers and electronic keyboards.
- MIDI is supported by several other instruments such as electronic drums, beat boxes, and even digital stringed instruments like guitars and violins.
- MIDI data includes several types of information.
- For ex – Pressing a single key on a synthesizer transmits the note played, the velocity (how hard the note is pressed), and how long the note is held.
- If multiple notes are played at once, the MIDI data is transmitted for all the notes simulteniously.

Personal Computer   Loud Speaker
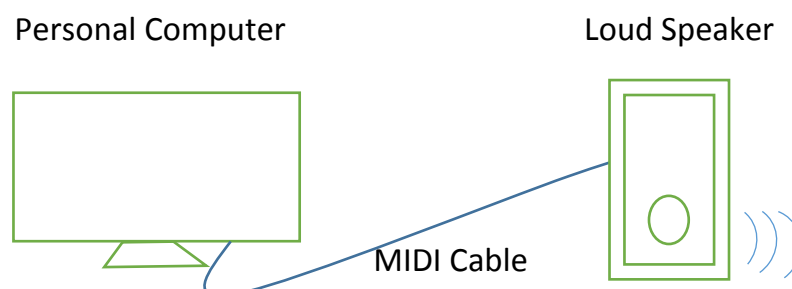
MIDI Cable

- Originally, MIDI connections used MIDI cables, which connected to a 5-Pin MIDI port on each device.
- Now most MIDI devices have standard computer interface , such as USB or thunderbolt ports.
- These modern interfaces provide more bandwidth than traditional MIDI ports, allowing more tracks with more data to be transmitted at once.

MIDI Devices:-

MIDI is a protocol designed for recording and playing back music on digital synthesizers that is supported by many makes of personal computer sound cards.

1. **Sound Generators :-**
- Sound generators are used to create / produce the sound and different synthesizers can control the sound generator.
- It is helps to produce an audio signals that becomes sound transferred into a loudspeaker.
- By changing the voltage oscillation of the audio signals, sound generator changes the quality of the sound.

2. **Microprocessor : -**
- Microprocessors communicate with the keyboard to know the which type of sound or note is playing and also communicate with control panel to know what type of commands of notes to sent to the microprocessor.

3. **Keyboard : -**
- Keyboard is used to control all the functionalities of sound.
- Keyboard is the direct control of the synthesizer which is very affordable to the musicians.
- Pressing kay on the keyboard it transmits signal to the microprocessor to know the what note to play and how long to play them.

4. **Control Pannel : -**
- The control pannel controls those functions that are not directly controlled by the keyboard.
- Control panel include – a slider that sets the overall volume of the synthesizer, the button that turns the synthesizer On and Off.

5. **Auxilary Controllers : -**
- It will give more control over the notes played on the keyboard.
- It is used to control the additional effects of sound.
- For Ex-   Incorporarting Effects, Recording different effects.

6. **Memory : -**
    - It is used to store patches for the sound generators and setting on the control panel.
    - Many devices have a slot for external memory cartridges.

MIDI Message :-

MIDI based instructions are called as MIDI Messages.

These message carry many information like what instrument to play in which channel and how to play.

MIDI message contain an entire music description language in binary format.
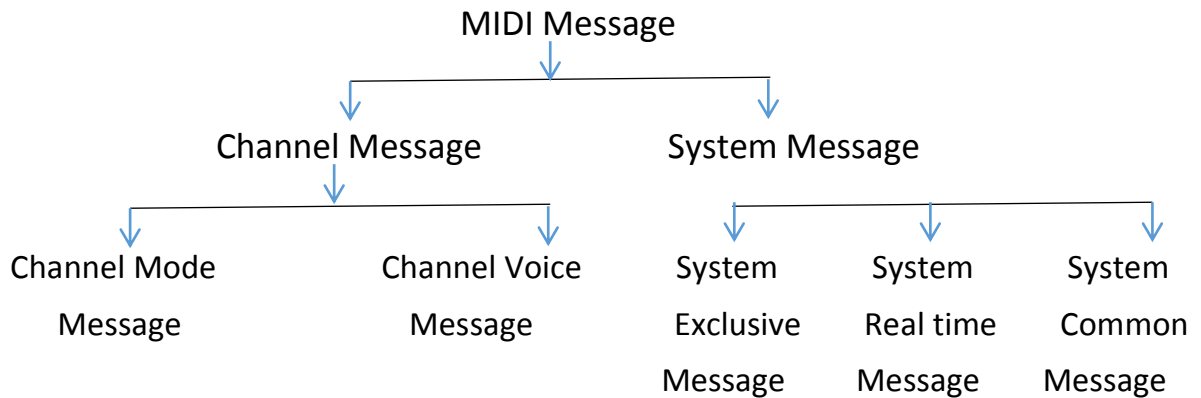
Each message consist of 1 or 3 bytes.

1 byte called as **status byte** and other 2 bytes called as **data bytes**.

a) Status Byte :-
- It contain the functions, operations to be performed and channel number which is to be affected.

b) Data Byte :-
   It providing the additional parameters on how to perform that operations.

Types MIDI Message :-

```
                          MIDI Message
                 ┌─────────────┴──────────────┐
          Channel Message              System Message
        ┌────────┴────────┐        ┌────────┼────────┐
   Channel Mode      Channel Voice  System    System    System
     Message            Message    Exclusive  Real time  Common
                                    Message    Message   Message
```

1. **Channel Message : -**
- Channel messages are applied to specific channel and channel number is included.
- For Ex - Note ON, Note Off,
- Here,
- Note On indicates the beginning of MIDI notes.
- It contain 3 bytes.
- 1st byte specifies Note On event and channel.
- 2nd byte specifies no.of note played.
- 3rd byte specifies velocity of notes.

   a) **Channel Voice Message :-**
   - It is carry musical performance data.

   b) **Channel Mode Message :-**
   - It is affect the way a receiving instrument will respond to the MIDI data or channel voice message.

2. System Message : -
- This message is not a channel specific, they affect the system as a whole and no channel number is indicated in their status byte.

a) System Real time Message :-
- It is used to synchronize the timing of MIDI device.
- For Ex- Include the timing clock message sets the tempo for play back of sequence and the start continue, stop message used to control playback of the sequence.

b) System Common Message :-
- It is the intended for all receiverin the system.
- They have commands that prepare sequencers and synthesizers to play the song.

c) System Exclusive Message :-
- Used to send data such as simple data between MIDI devices.

4.3 Digital Audio :-

- Digital audio is a representation of an analog audio signal used by computers and digital devices to record and playback sound.
- It is used to represent the sound.
- It is sound that has been recorded as well as converted into digital form.
- Similar to the frames of a video, digital audio is made up of a series of sample which recreate a sound when played back in sequence.
- AudioSignals are stored in the samples.
- Digital audio is widely used in MM projects because it provide many facilities.
- For ex – It allows the user to select the no. of applications software and system to support for digital audio for editing the sound.
- Digital audio has main two parameters i. e

- Sample Rate
- Bit Depth

- Sample Rate :-
  - Sample rate is how many times per second the sound is sampled (recorded).

- Bit Depth :-
  - Bit depth is the amount of dynamic range(Frequency) of each sample.

- To convert audio into binary code, the take tens of thousands of samples per second.
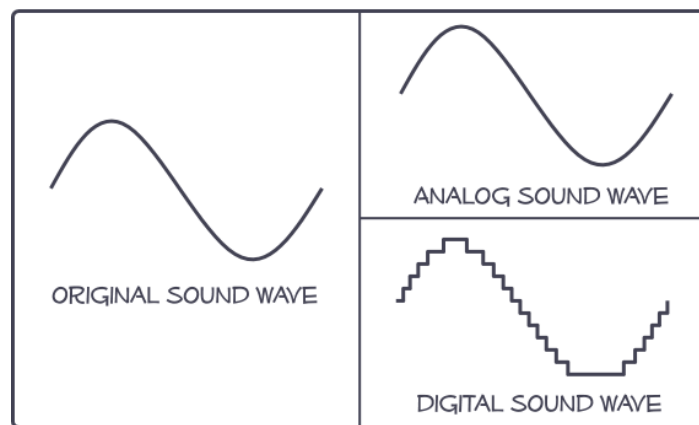
- These digital signals are enough to produce excellent sound quality.
- The following figure shows the analog wave forms, which are sampled at different frequencies and then each descript sample stored in 8 bits or 16 bits of the data.
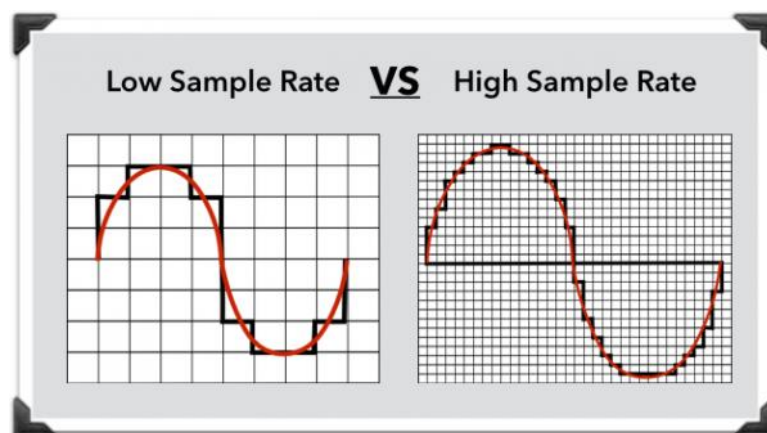
- Sample rate can build a far more accurate picture of the analog signal.
- It has better sound quality.
- Common sample rates for CD quality i.e 44.1KHz.
- The sample size larger then the better data describes recording of sounds.
- A 8 bit sample size provide 256 equal units for dynamic range(bit depth)
- A 16 bit sample size provides 65536 equal units for dynamic range.

4.4 Audio File Format :-

- An audio file format is a file format for storing digital audio data on a computer system.
- Audio files can be upcompressed or compresses to the file size.
- It is an example of lossy data compression.
- We can use background music for giving information about the topics.
- In Mac O.S the digitized sound stored as a data files.
- For application , Mac uses file structure.
- In windows O.S the digitized sound stored as a wave file formats.
- It stores the sound in bit & bytes to create sampled form of sound.

There are some audio file formats which are used to store sound and digital audio, they are as follows :

1) Audio Interchange File Format (.aiff)
2) Moving Picture Expert Group (MPEG- .mp3)
3) Wave Audio File Format (.wav)
4) Musical Instrument Digital Interface (MIDI - .mid / .midi)

1) Audio Interchange File Format (.aiff) :-

- It is an audio file format standard used for storing sound data for personal computers and other electronic audio devices.
- It is uncompressed file format.
- It was introduced by Macintosh O.S.
- The extension of this file format is .aiff.

2) Moving Picture Expert Group (MPEG- .mp3) :-
- MPEG stands for Moving Picture Expert Group.
- In which lossy data compression is used.
- It require one minuteof music takes up approximately 1MB storage space.
- The extension of this file format is .mp3.

3) Wave Audio File Format (.wav) :-
- It is an audio file format standard used for storing sound data.
- It is uncompressed file format.
- It is not free format that is sponsored by Microsoft and IBM.
- It require 1 minute audio need 10 MB storage space.
- The extension of this file format is .wav.

4) Musical Instrument Digital Interface (MIDI - .mid / .midi) :-
- It is an also audio file format standard used for storing sound data.
- It is description of how to create the sound based on predefined sounds like guitar, piano, drum etc.
- MIDI recording never contains the human voice.
- A 10KB MIDI file had more than a minute of music.
- The extension of this file format is .mid / .midi.
- It is not compressed.
- MIDI files available on both O.S i.e. Mac O.S and Windows.

Question Bank

1. Explain Basic Sound Concepts.   5M
2. Explain the Concept of MIDI.   5M
3. Explain the Concept of Digital Audio.   5M
4. Write Short notes on following :
   a. MIDI   3M
   b. Audio File Formats   3M