Marwadi University	**Marwadi University** **Faculty of Technology** **Department of Information and Communication Technology**	
Subject: Analog and Digital Communications(01CT0404)	**Aim:** To Revise the Entire Syllabus in Shorter Period of Time and get the things on a same place.	
ESE Question Bank	**Date:-** 26-04-2024	**Enrollment No:-** 92200133030

1) Justify need of modulation in detail.

Ans :- The Need of Modulation consider the following points

I. **Avoids mixing of signals:** Modulation allows multiple signals to coexist without interfering with each other by imposing unique characteristics on each signal, such as frequency or amplitude variations.
II. **Reduces the height of an antenna:** By modulating signals onto a carrier wave, the frequency of the transmitted signal can be increased, enabling the use of shorter antennas while maintaining effective transmission range.
III. **Increases range of communication:** Modulation techniques like amplitude modulation (AM) and frequency modulation (FM) help in overcoming signal attenuation and noise, allowing for longer-distance communication without significant loss of signal strength.
IV. **Multiplexing is possible:** Modulation enables the combining of multiple signals onto a single transmission medium through techniques like frequency division multiplexing (FDM) or time division multiplexing (TDM), optimizing bandwidth utilization and allowing for simultaneous transmission of multiple signals.
V. **Improves quality of reception:** Modulation helps in reducing the impact of noise and interference during transmission, resulting in clearer reception at the receiving end, thus enhancing the overall quality of communication.

2) Summarize the advantages of SSBSC modulation

Ans :- Single-Sideband Suppressed Carrier (SSBSC) modulation offers several advantages:-

- **Bandwidth Efficiency:** SSBSC eliminates one sideband and the carrier, effectively reducing the necessary bandwidth compared to Double-Sideband (DSB) modulation. This makes SSBSC more spectrum-efficient.
- **Power Efficiency**: By transmitting only one sideband, SSBSC requires less power compared to DSB modulation for the same signal quality. This leads to more efficient power usage in transmission.
- **Improved Signal-to-Noise Ratio (SNR):** Since SSBSC transmits only one sideband, it reduces the effect of noise compared to DSB modulation, resulting in an improved SNR.
- **Reduced Interference:** SSBSC minimizes interference with adjacent channels since it occupies less bandwidth. This makes it suitable for applications where spectrum congestion is a concern.
- **Higher Transmission Distance:** With improved SNR and reduced interference, SSBSC can transmit signals over longer distances with better clarity compared to DSB modulation.
- **Compatibility with Single-Sideband Receivers:** SSBSC is compatible with receivers designed to demodulate single-sideband signals, which are widely available and commonly used in communication systems.

3) Compare AM techniques DSBSC, SSB and VSB.

Ans :-

Parameter	**DSBSC**	**SSB**	**VSB**
Sideband Transmission	Both sidebands transmitted	One sideband completely suppressed, carrier optional	One sideband partially transmitted, carrier suppressed
Bandwidth	2fm (fm = modulating signal frequency)	fm (most efficient)	Slightly greater than fm
Spectral Efficiency	Moderate (50% wasted power in carrier)	Maximum (all power in information)	Moderate (some wasted power)
Power Efficiency	Medium	Low	Medium
Implementation Complexity	Low	High (requires sideband selection filters)	Moderate (requires partial sideband transmission filters)
Noise Performance	Average	Average (depends on transmitted sideband)	Can be slightly better than DSBSC (reduced bandwidth)
Applications	Limited (historical)	Long-distance radio communication (e.g., HF radio)	Television broadcasting (bandwidth vs. information trade-off)

4) Compare NBFM and WBFM.

S.No.	**Parameter/Characteristics**	**Wideband FM**	**Narrowband FM**
1.	Modulation index	Greater than 1	Less than or slightly greater than 1
2.	Maximum deviation	75 kHz	5 kHz
3.	Range of modulating frequency	30 Hz to 15 kHz	30 Hz to 3 kHz
4.	Maximum modulation index	5 to 2500	Slightly greater than 1
5.	Bandwidth	Large about 15 times higher than BW of narrowband FM	Small. Approximately same as that of AM
6.	Applications	Entertainment broad-casting (can be used for high quality music transmission)	FM mobile communication like police wireless, ambulance etc. (This is used for speech trans-mission)
7.	Pre-emphasis and De-emphasis	Needed	Needed

5) Compare Amplitude modulation and Frequency modulation and Phase modulation.

Feature	Amplitude Modulation (AM)	Frequency Modulation (FM)	Phase Modulation (PM)
Modulated Characteristic	Amplitude of carrier wave	Frequency of carrier wave	Phase of carrier wave
Information Signal	Varies the amplitude of the carrier wave according to the information signal.	Varies the frequency of the carrier wave according to the information signal.	Varies the phase of the carrier wave according to the information signal.
Bandwidth	Requires twice the bandwidth of the information signal (fm) due to double sidebands (can be reduced with SSB techniques).	Wider bandwidth compared to AM, proportional to the modulation index and information signal frequency.	Bandwidth depends on modulation index and information signal frequency, generally wider than AM but narrower than wideband FM.
Noise Performance	Susceptible to noise (amplitude variations from noise can be interpreted as information).	More resistant to noise (information encoded in frequency variations, less affected by amplitude changes).	Moderately resistant to noise (information in phase variations, somewhat affected by amplitude changes).
Spectral Efficiency	Less efficient due to wasted power in carrier (DSBSC) or redundant sidebands (AM).	More efficient, all power carries information.	Moderately efficient, some wasted power depending on modulation index.
Implementation Complexity	Relatively simpler circuits.	More complex circuits due to need for accurate frequency deviation control.	Complexity between AM and FM.
Applications	AM radio broadcasting (older technology), low-fidelity communication.	FM radio broadcasting, high-fidelity communication, satellite communication.	Niche applications like radar, color TV transmission (component carrier).

6) Write functions of radio receiver.

The main functions of a radio receiver can be summarized in three key steps:

1. **Selection:**
   - Intercept incoming radio waves with the antenna.
   - Filter out unwanted signals and noise using electronic filters. These filters allow only the desired radio frequency (corresponding to the chosen radio station) to pass through.
   - It is the one of the most important characteristics of any receiver.

2. **Amplification:**
   - Amplify the weak selected signal to a usable level for further processing. This is because the signal received by the antenna is very faint.
3. **Demodulation:**
   - Recover the original information (audio or data) carried by the radio wave. This involves separating the information signal from the carrier wave. The type of demodulation used depends on the modulation technique employed during transmission (AM, FM, etc.).

- **For Amplitude Modulation (AM):** Demodulation extracts the changes in amplitude of the carrier wave, which correspond to the information signal.
- **For Frequency Modulation (FM):** Demodulation recovers the information signal from the variations in the frequency of the carrier wave.

7) State the principle of Super heterodyne receiver.

➢ The superheterodyne receiver, often shortened to superhet, is a cornerstone of modern radio design. It works based on the principle of frequency mixing to convert a received signal at a high radio frequency (RF) to a fixed intermediate frequency (IF) for easier processing. Here's a breakdown of the principle:

1. **Mixing:**
   - The received RF signal is mixed with a locally generated signal from a tunable oscillator (LO) within the receiver.
   - This mixing process, using a non-linear element like a mixer diode, creates new sum and difference frequencies at the output.
2. **Intermediate Frequency (IF):**
   - The desired output of the mixing stage is the difference frequency between the RF signal and the LO signal. This difference frequency is called the Intermediate Frequency (IF).
   - The key advantage is that the IF is fixed, regardless of the original RF received. This allows the receiver to use high-performance, narrowband filters tuned to the specific IF for better selectivity and noise rejection.
3. **Demodulation:**
   - After amplification, the IF signal is demodulated using appropriate circuits depending on the modulation technique used (AM, FM, etc.). This extracts the original information signal from the carrier.
4. **Benefits:**
   - Superheterodyne architecture allows receivers to tune to a wide range of radio frequencies using a variable LO while keeping the IF processing section fixed and optimized.
   - It simplifies filter design and improves image rejection (reducing interference from unwanted frequencies).
   - This principle enables the design of more sensitive and selective radio receivers.

8) Describe phase deviation, modulation index, and frequency deviation and percent modulation.

1. Phase Deviation (Δφ):

- In both FM and PM, phase deviation refers to the **maximum change** in the phase of the carrier wave relative to its unmodulated state.
- It's measured in **radians**.

2. Modulation Index (m):

- Modulation index (m) is a dimensionless parameter that quantifies the **extent of frequency deviation** in an FM wave relative to the modulating signal frequency (fm).
- It's calculated as the ratio of the peak frequency deviation (Δf) of the carrier wave to the modulating signal frequency (fm).
    - m = Δf / fm
- A higher modulation index signifies a larger swing in the carrier's frequency for a given change in the information signal.

3. Frequency Deviation (Δf):

- Frequency deviation (Δf) refers to the **maximum amount** by which the instantaneous frequency of the carrier wave deviates from its unmodulated center frequency due to the modulation.
- It's measured in **Hertz (Hz)**.
- Frequency deviation is directly proportional to the modulation index (m) and the modulating signal frequency (fm).

4. Percent Modulation (% Modulation):

Not used for FM or PM:

- Percent modulation (% Modulation) is a concept used in Amplitude Modulation (AM) and describes the **percentage change in the amplitude of the carrier wave** relative to its unmodulated level. It's not applicable to angle modulation techniques like FM and PM.

9) Compare PAM, PWM and PPM system.

Feature	PAM	PWM	PPM
Modulated Parameter	Amplitude of the pulse	Width (duration) of the pulse	Position of the pulse
Signal Type	Analog	Can be Analog or Digital	Can be Analog or Digital
Information Encoding	Analog information varies the pulse amplitude	Analog information varies the pulse width	Analog information varies the pulse position
Bandwidth Requirement	Depends on the highest modulating frequency	Generally lower bandwidth than PAM for similar information	Can be higher bandwidth than PAM depending on the number of positions
Noise Performance	More susceptible to noise in the amplitude	Less susceptible to noise in amplitude variations	Less susceptible to noise in amplitude variations
Complexity	Simpler circuits	Moderate complexity	More complex circuits than PAM and PWM
Applications	Limited use (obsolete for most applications)	Motor speed control, LED dimming (analog), Digital control signals (digital)	Low-power wireless communication (e.g., remote controls)

10) State advantages of ADM over DM.

Here are the advantages of Adaptive Delta Modulation (ADM) over Delta Modulation (DM):

- **Reduced Slope Overload Distortion:** Delta Modulation suffers from slope overload distortion when a large and rapid change occurs in the input signal. The fixed step size in DM can't keep up with these fast changes, leading to a clipped or distorted output waveform. ADM overcomes this by dynamically adjusting the step size, allowing it to handle larger signal variations more accurately.
- **Reduced Granular Noise:** Granular noise is another issue with Delta Modulation. It appears as a quantization error in the form of unwanted noise steps in the reconstructed signal. ADM addresses this by using a variable step size. Smaller step sizes are used for smaller signal changes, resulting in finer quantization and less granular noise.
- **Improved Signal-to-Noise Ratio (SNR):** By reducing both slope overload distortion and granular noise, ADM achieves a higher overall signal-to-noise ratio (SNR) compared to Delta Modulation. This translates to a cleaner and more faithful reproduction of the original signal.
- **Robustness to Bit Errors:** Delta Modulation is sensitive to bit errors in the transmission channel. A single bit error can significantly alter the reconstructed signal. ADM offers improved robustness because the quantization errors are smaller and less prone to causing large deviations in the reconstructed signal when bit errors occur. This reduces the need for complex error detection and correction techniques in the receiver.
- **Wider Dynamic Range:** The variable step size in ADM allows it to handle a wider range of input signal amplitudes compared to the fixed step size in Delta Modulation. This makes ADM more versatile for signals with varying dynamic characteristics.

11) Compare ASK and FSK

Feature	**ASK**	**FSK**
Modulated Parameter	Amplitude of the carrier wave	Frequency of the carrier wave
Information Encoding	Binary data (0/1) represented by variations in carrier amplitude	Binary data (0/1) represented by variations in carrier frequency
Signal Type	Analog	Analog
Bandwidth Requirement	Relatively narrow bandwidth (approximately equal to the data rate)	Wider bandwidth than ASK (depends on frequency deviation and data rate)
Noise Performance	More susceptible to noise in the amplitude	Less susceptible to noise in the amplitude
Complexity	Simpler circuits	Moderate complexity
Data Rate	Suitable for lower data rates	Can handle higher data rates compared to ASK for similar noise performance
Applications	Low-power applications, short-range communication (e.g., RFID tags)	More common in higher-frequency applications (e.g., some wireless keyboards, FSK modems)