JYOTHISHMATHI INSTITUTE OF TECHNOLOGY & SCINCE

PPT ON PHASE MODULATION

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FREQUENCY AND PHASE MODULATION (ANGLE MODULATION)

- ANGLE MODULATION –
- When frequency or phase of the carrier is varied by the modulating signal , then it is called angle modulation.
- Frequency Modulation – When the frequency of the carrier varies as per amplitude of modulating signal, then it is called frequency modulation (FM).
- Phase Modulation - When the phase of the carrier varies as per amplitude of modulating signal, then it is called phase modulation (PM).
- <u>Amplitude of the modulated carrier remains constant in both modulation systems.</u>

- An important feature of angle modulation:
- It can provide a better discrimination (robustness) against noise and interference than AM.
- This improvement is achieved at the expense of increased transmission bandwidth.
- In case of angle modulation, channel bandwidth may be exchanged for improved noise performance
- Such trade-off is not possible with AM

- BASIC DEFINITIONS -Relationship between the angle and frequency of a sinusoidal signal
- Sinusoidal carrier $c(t) = A_c \cos[\theta_i(t)]$
- Angle of carrier $\theta_i(t)$[rad]
- Instantaneous frequency of carrier $f_i(t) = (1/2\pi)\omega_i(t) = (1/2\pi) d_i(t)/dt$
- $= (1/2\pi)\dot{\theta}_i(t)$[Hz].
- In the case of an un-modulated carrier, the angle becomes $\theta_i(t) = 2\pi f_c t + \theta_c$

- Compare FM-PM –
- The basic difference between FM & PM lies in which property of the carrier is directly varied by modulating signal.
- In FM, the frequency of carrier is varied directly.
- In PM, phase of the carrier is varied directly. Instantaneous phase deviation is represented by $\theta(t)$.
- Instantaneous phase= $\omega ct + \theta(t)$ rad.

- Instantaneous frequency deviation =
- $d/dt \{\theta(t)\} = \theta'(t)$ Hz.
- The <u>instantaneous frequency deviation </u>is the instantaneous change in carrier frequency and is equal to the rate at which instantaneous phase deviation takes place.
- Instantaneous frequency is defined as frequency of the carrier at a given instant of time and is given as
  $\omega i(t) = d/dt\, [\omega c.t + \theta(t)] = \omega c + \theta'(t)$ rad/sec.

- Instantaneous phase deviation $\theta(t)$ is proportional to modulating signal voltage, $\theta(t) = k\, e_m(t)$ rad. (k is deviation sensitivity of phase.).
- Instantaneous frequency deviation $\theta'(t)$ is proportional to modulating signal voltage, $\theta'(t) = k_1\, e_m(t)$ rad. (k1 is deviation sensitivity of frequency.)##2

- Observations from the FM & PM waveforms –
- 1. Both FM & PM waveforms are identical except the phase shift.
- 2. For FM, the maximum frequency deviation takes place when modulating signal is at +ve and –ve peaks.
- 3. For PM, the maximum frequency deviation takes place near zero crossing of the modulating signal.
- 4. It is diffcult to know from modulated waveform whether the modulation is FM or PM. (##3)

- Bandwidth Requirement – for FM-
- The BW requirement can be obtained depending on the modulation index (M.I).
- The M.I. can be classified as high(more than 10), medium (1 to 10) and low (less than 1).
- The low index systems are called narrowband FM in which frequency spectrum resembles AM. BW (fm) =2fm Hz.
- For high index modulation, BW = 2*δ.(Freq. dev.)
- BW can also be found out by Bessel table- BWfm = 2.n.fm where n is the number of sidebands obtained from table.

- Carson's Rule –
- Rule gives approximate minimum BW of angle modulated signal as
- BW fm = 2{δ + fm(max)} Hz.
- From the above equation, it is found that the BW accommodates almost 98% of the total transmitted power

- Bandwidth for PM –
- BW for PM is expressed as
- $BW_{pm} = 2(m_p+1)f_m$.