SRM Institute of Science and Technology

Tiruchirappalli Campus, Trichy – 621 105

Faculty of Engineering and Technology

Department of Electronics and Communication Engineering

21ECC302T: ANALOG AND DIGITAL COMMUNICATION

Assignment 01: **Date of Submission: 07.03.2025**

1. What are the needs for modulation?
2. Compare the merits and demerits of AM and FM.
3. Find the Hilbert Transform of $\sin(2\pi f_c t)$
4. A 20MHz sinusoidal carrier wave of amplitude 10mV is modulated by a 5KHz sinusoidal audio signal wave of amplitude 6mV. Find the frequency components of the resultant modulated wave and their amplitudes.
5. A carrier is frequency modulated with a sinusoidal signal of 2KHz resulting in a maximum frequency deviation of 4KHz. Find the modulation index, β and the transmission bandwidth, B_T.
6. An amplitude modulated carrier wave has maximum and minimum amplitudes of 18V and 6V. Determine modulation index and the unmodulated carrier amplitude, assuming sinusoidal modulation.
7. Explain the principle and operation of super heterodyne receiver.
8. Explain in detail about the Indirect Method of FM Generation.
9. Explain briefly about the Generation and Detection of AM signal using Square Law Modulator and Square Law Detector (Non – Linear Method).
10. Explain the working principles of Ring modulator to generate a DSBSC Modulated signal and how to detect the original reconstructed signal from coherent Detector.
11. Explain in detail about the detection of DSB – SC waves using a COSTAS receiver with necessary equations and neat block diagram.
12. Explain briefly about the Generation of AM – DSB/FC signal. Derive the expression for AM wave, and also derive the total power delivered for the AM signal.
13. For an DSB-FC wave with a peak unmodulated carrier voltage 12V peak, a load resistance of $R_l = 8\Omega$ and modulation index $m = 1$, determine (i) Power of the carrier and the sidebands (ii) Total sideband power (iii) Total power of the modulated wave (iv) Efficiency percentage.
14. The signal applied to the non – linear device is relatively weak, such that it can be represented by a square law: $v_2(t) = a_1 v_1(t) + a_2 v_1^2(t)$, where a_1, a_2 are constants. $v_1(t)$ is the input voltage and $v_2(t)$ is the output voltage. The input voltage is defined by $v_1(t) = A_c.\cos(2\pi f_c t) + m(t)$, where m(t) is a message signal and $A_c.\cos(2\pi f_c t)$ is a carrier wave.
    (i) Evaluate the output voltage $v_2(t)$.
    (ii) Specify the frequency response that the tuned circuit must satisfy in order to generate an AM signal with f_c as the carrier frequency.
    (iii) What is the amplitude sensitivity of this AM signal?
15. Using the message signal $m(t) = 1/(1+t^2)$, determine the modulated waves for the following methods of modulation,
    (a) Amplitude modulation with 50 percent modulation
    (b) Double sideband – suppressed carrier modulation
    (c) Single side band modulation with only the upper side band transmitted.
    (d) Single side band modulation with only the lower side band transmitted.

16. Generate SSB Wave, $s(t)$ using Phase Discrimination Method, draw the spectrum of the SSB wave and explain the process of recovering the baseband signal using coherent detection.
17. A $20MHz$ carrier is frequency modulated by a sinusoidal signal such that the peak frequency deviation is $100kHz$. Determine the modulation index and the approximate bandwidth of the FM signal if the frequency of the modulating signal is (i) $1kHz$ (ii) $50\,kHz$ (iii) $500\,kHz$
18. The single tone modulating signal, $m(t) = A_m.\cos(2\pi f_m t)$ is used to generate the VSB signal, $s(t) = (1/2).a.A_m.A_c.\cos[2\pi(f_c + f_m)t] + (1/2).A_m.A_c(1-a).\cos[2\pi(f_c - f_m)t]$
, where, 'a' is a constant, less than unity, representing the attenuation of the upper side frequency.
    (a) Find the Quadrature component of the VSB signal s(t).
    (b) The VSB signal, plus the carrier $A_c.\cos(2\pi f_c t)$, is passed through an envelope detector. Determine the distortion produced by the Quadrature component.
    (c) What is the value of constant, 'a' for which this distortion reaches its worst possible condition.
19. An angle modulated signal with carrier frequency, $\omega_c = 2\pi * 10^5$ is described by the Equation, $\phi_{EM}(t) = 10.\cos(\omega_c t + 5.\sin 3000t + 10.\sin 2000\pi t)$.
    (a) Find the power of the modulated signal
    (b) Find the frequency deviation, Δf
    (c) Find the deviation ratio, β
    (d) Find the phase distortion, $\Delta\phi$
    (e) Estimate the bandwidth of $\phi_{EM}(t)$
20. Derive the expression for demodulation of FM waves and explain the operation of a Balanced Frequency Discriminator with neat diagram.
21. Obtain the expression for the DSB-SC – AM Signal, $y(t)$ using a balanced modulator and receive the DSB-SC signal in the presence of Noise. Derive the expressions for $SNR_{O,AM}$, $SNR_{C,AM}$ and Figure of Merit.
22. Obtain the expression for Pre-detection SNR, Post detection SNR and also Figure of Merit (FoM) for a Single Sideband System.
23. A DSB-SC modulated signal is transmitted over a noisy channel with power spectral density of noise expressed as $S_N(f) = \begin{cases} 10^{-6} & -400kHz < f(kHz) < 400kHz \\ 0 & otherwise \end{cases}$. The message bandwidth is $4kHz$ and the carrier frequency is $200kHz$. Assuming that the average power of the modulated wave is 10Watts, determine the output SNR of the receiver.
24. Let a message signal $m(t)$ be transmitted using single sideband modulation. The Power spectral density of $m(t)$ is $S_m(f) = \begin{cases} a\frac{|f|}{W}, & |f| \le W \\ 0 & otherwise \end{cases}$, where a and W are constants. White Gaussian noise of zero mean and Power spectral Density, $N_0/2$ is added to the Single Sideband Modulated Wave at the receiver input. Find an expression for the output signal to noise ratio of the receiver.
25. Derive the expression and obtain the channel SNR, Output SNR, and Figure of Merit of FM receivers.

*****