INDIAN INSTITUTE OF INFORMATION TECHNOLOGY RANCHI
SEMESTER: SPRING, SESSION: 2022 – 23
End Semester Examination: B. Tech. (ECE) IV Semester

Course code: EC-2008/EI-2008 **Course Title: Analog Communication**
Duration: 3 Hours **Max Marks: 100**

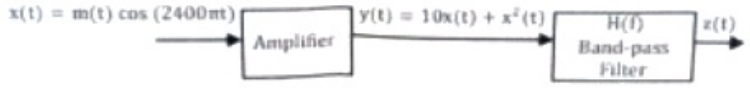
Important Instructions:

- *Section-1 is compulsory. Attempt any four questions from section-2.*
- *Associated marks of questions are mentioned within square brackets i.e.[].*
- *Write all parts of one question at one place only.*

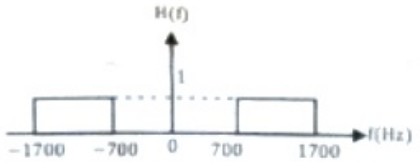
Section-1

1. (a) For a superheterodyne receiver, the intermediate frequency is 28 MHz and the local oscillator frequency is 4.2 GHz. If the frequency of the received signal is greater than the local oscillator frequency, then calculate the image frequency (in MHz). Describe sensitivity and selectivity for superheterodyne receiver using suitable diagram. [6]

(b) In the system shown in figure (a), m(t) is a low pass signal with bandwidth W Hz. The frequency response of the band pass filter H(f) is shown in figure (b). Draw the spectrum and calculate the maximum value of W (in Hz), if it is desired that output signal z(t) = 10 x(t). [6]



(a)



(b)

2. (a) A modulating signal is given by $x(t) = 5\sin(4\pi 10^3 t - 10\pi cos 2\pi 10^3 t)$ V is fed to a phase modulator with phase deviation constant $k_p = 5\ rad/V$. If the carrier frequency is 20 kHz, calculate the instantaneous frequency (in kHz) at $t = 0.5$ ms. [6]

(b) The amplitude of a sinusoidal carrier is modulated by a single sinusoid to obtain the amplitude modulated signal $s(t) = 5cos1600\pi t + 20cos1800\pi t + 5cos2000\pi t$. Calculate the value of modulation index. Also calculate the total transmitted power if modulation index is reduced to half. [6]

3. (a) Consider a narrow-band FM signal approximately defined by [6]

$$s(t) \cong A_c \cos(2\pi f_c t) - \beta A_c \sin(2\pi f_c t)\sin(2\pi f_m t)$$

i. Determine the envelope of this modulated signal. What is the ratio of the maximum to the minimum value of this envelope? Plot this ratio versus β, assuming that β is restricted to the interval $0 \leq \beta \leq 0.3$.

ii. Determine the average power of the narrow-band FM signal, expressed as a percentage of the unmodulated carrier wave. Plot this result versus β, assuming that β is restricted to the interval $0 \leq \beta \leq 0.3$.

(b) Differentiate Fourier transform and Hilbert transform with suitable examples. [6]

4. (a) Derive an expression of modulated wave for wideband FM with suitable diagrams. [6]

(b) In a broadcast superheterodyne receiver Q=100, if IF=455 kHz, calculate the image frequency and rejection ratio at 2 MHz. [6]

5. (a) Derive an expression for modulated signal of SSB-SC using phase discriminator method. [6]

(b) A carrier wave of frequency 100 MHz is frequency modulated by a sinusoidal wave of amplitude 20 volts and frequency 100 kHz. The frequency sensitivity of the modulator is 25 kHz per volt. [6]

i. Determine the approximate bandwidth of the FM signal using Carson's rule.

ii. Determine the bandwidth by transmitting only those side frequencies whose amplitudes exceed 1 percent of the unmodulated carrier amplitude with $\beta = 5$.

Section-2

6. Describe the operation of phase-locked loop using suitable expressions and diagrams. Also discuss the wide band frequency modulator using voltage-controlled oscillator. [10]

7. Discuss the use of pre-emphasis and de-emphasis filter to improve the performance of FM system with suitable diagrams. [10]

8. Discuss the modulation techniques for AM using suitable diagrams. [10]

9. Describe the advantages and drawbacks of SSB-SC and VSB. Discuss any modulation and demodulation technique of VSB signal. [10]

10. Describe bandpass noise and derive an expression for output signal-to-noise ratio of DSB-SC receiver using synchronous detection. [10]