Mid semester Examination
Analog Communication (EC31001)
Full marks: 60

Attempt all the 4 questions. Each question carries 15 marks.

1. (a) If two signals $x_1(t)$ and $x_2(t)$ are complex function then from the first principle prove that they are orthonormal over and interval $t_1 \leq t \leq t_2$ as long as

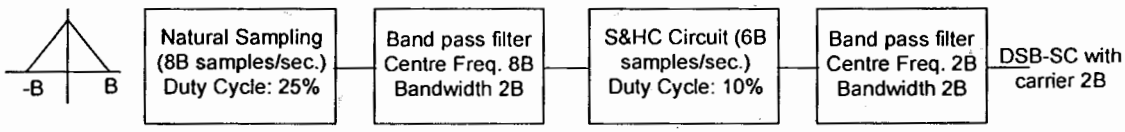
$$\int_{t_1}^{t_2} x_1(t)x_2^*(t)dt = 0 \qquad \text{or} \int_{t_1}^{t_2} x_2(t)x_1^*(t)dt = 0$$

Where the symbol carries their usual meaning.
(b) Define energy and power of a signal g(t). For a periodic signal, with the help of Fourier representation, prove the Parseval's theorem.
(c) For a real periodic signal g(t) if D_n's are the corresponding exponential Fourier series coefficients, then prove the relationship between D_n and D_{-n}.
7+4+4

2. (a) Define Convolution theorem (i.e., the relationship between time domain convolution and frequency domain multiplication) and prove it. Use this theorem to calculate the bandwidth of the square of a band-limited signal with baseband bandwidth of B.
(b)Derive the relationship between the signal energy and the signal amplitude spectrum of an energy signal? From there define energy spectral density of the same signal. What is time auto correlation function? Derive the relationship between time auto correlation function and energy spectral density.
(c) Define signal power and power spectral density of a periodic signal.
5+7+3

3. (a) What is vestigial side band modulation? What is it required? Derive the relationship between the input and the output filter of VSB modulation? Derive the time domain representation of a VSB modulated signal. Why carrier phase can not be extracted from a VSB modulated signal by squaring the signal?
(b) What is quadrature amplitude modulation? How it is advantageous to SSB or DSB? How QAM modulated signals $m_1(t)$ and $m_2(t)$ can be demodulated? What will be the output of the demodulation if the local oscillator of the demodulator has a constant phase shift of Δ with the incoming carrier?
9+6

4. (a) A DSB-SC modulator is designed as follows:



The message signal is band limited with baseband bandwidth B. It is first sampled at 8B samples per second with natural sampling. The sampling pulse has a duty cycle of 25%. The circuit is then followed by an ideal bandpass filter of centre frequency 8B and bandwidth 2B. Next the signal is sampled at 6B samples per second with a sample and hold circuit (S&HC) followed by another ideal bandpass filter of centre frequency 2B and bandwidth 2B. The pulse duty cycle of the S&HC is 10%. Assuming that the attenuation due to S&HC circuit remains almost constant within the entire signal band with a value equivalent to the value at the central frequency, derive how much power the final DSB-SC signal will have if the input power of the message signal is P.

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