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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, NOVEMBER 2019
COMMUNICATION SYSTEMS [ELE 3103]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date:20 November 2019** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Let the input voltage applied to the nonlinear square law device is $V_1(t) = A_c cos2\pi f_c t + m(t)$ and the output of the device is represented as $V_2(t) = a_1 V_1(t) + a_2 V^2{}_1(t)$, where m(t) is the message signal and $A_c \cos 2\pi f_c t$ is the carrier wave.

a) Evaluate $V_2(t)$ in terms of standard AM equation.

b) Specify the frequency response that the band pass filter must satisfy in order to generate an AM signal with f_c as carrier frequency, assume m(t) is band limited to the interval $-W \le f \le W$.

c) What is the amplitude sensitivity of this AM signal? ***(04)***

1B. The local oscillator used for the demodulation of a single tone modulated SSB signal s(t) has a frequency error Δf measured with respect to the carrier frequency f_c used to generate s(t). Otherwise, there is perfect synchronism between this oscillator in the receiver and the oscillator supplying the carrier wave in the transmitter. Evaluate the demodulated signal by considering the SSB signal s(t) as upper sideband only. (Assume: message signal = $A_m cos2\pi f_m t$, carrier signal = $A_c cos2\pi f_c t$) ***(03)***

1C. Suppose that the message signal is given as, $m(t) = 10 + 4cos\ 2\pi t + 8\ cos\ 4\ \pi t + 10\ cos\ 20\ \pi t$ and the carrier signal to be c(t)=cos2 $\pi f_c t$. Specify the frequency response characteristics of a VSB filter that passes the upper sideband. ***(03)***

2A. Consider an incoming narrow band AM signal of bandwidth 10KHz in a super heterodyne receiver, and mid band frequency that may lie in the range 0.535MHz and 1.605MHz .It is required to translate this signal to a fixed frequency band centered at 0.455MHz.Determine the range of tuning that must be provided in local oscillator for the AM super heterodyne receiver. ***(02)***

2B. An indirect wideband frequency modulator is used to transmit audio signal with frequency 100Hz. The narrowband phase modulator is supplied with a carrier of frequency fc= 0.1MHz by a crystal controlled oscillator. A second crystal reference oscillator supplies a sinusoidal wave of frequency 9.5MHz to the mixer (consider local oscillator frequency is greater than frequency of first multiplier output). The system specifications are as follows:

Carrier frequency at the transmitter output, f_t = 100MHz

Frequency deviation at the transmitter = 75KHz

Modulation index at the Narrow band modulator = 0.2 rad

a) Calculate the frequency multiplication ratios n1 and n2, which will satisfy these specifications.

b) Specify the values of the frequencies and frequency deviation at various points of the modulator. ***(04)***

2C. Let the message signal $m(t) = 6\cos(2 \times 10^2 \pi t)$ frequency modulates the carrier signal $c(t) = 8\cos(20 \times 10^6 \pi t)$ with k_f = 50Hz/volt. Plot the positive side spectrum of WBFM signal using Bessel function table (Table 1). Calculate the power of modulated signal present in the carrier and in the significant side frequency components. ***(04)***

3A. For a message signal x(t) which is a sum of two cosine signals, spectrum is as shown in Figure Q3A. x(t) is sampled at the rate of 350 samples per second. Sampled signal is passed through an ideal low pass filter with a cutoff frequency of 200Hz.

i) Sketch the sampled signal

ii) Sketch the spectrum for the output of the LPF

iii) Write an expression for the output of LPF in time domain. ***(04)***

3B. A signal $s_2(t)$ shown in Figure Q3B is applied at the input of an integrator and dump circuit. Plot the output as a function of time. ***(03)***

3C. Figure Q3C shows the spectrum of a message signal x(t). The signal is sampled at a rate equal to 1 KHz using flat top pulses, with each pulse being of 1V amplitude and of duration 0.1ms. Determine and sketch the spectrum of resulting PAM signal. ***(03)***

4A. Consider the transmitted shift keyed signal, $s_i(t) = \sqrt{\frac{2E}{T}} \cos(2\pi f_c t + i\frac{\pi}{4})$, $0 \le t \le T$, where

E- symbol energy, T- symbol duration, i = 1,2,3,4 and f_c is an integer multiple of 1/T.

i) Determine the orthonormal basis functions to represent this set of signals.

ii) Determine the coefficients s_{ij} of the signal $s_i(t)$.

iii) Plot the coordinates of message points of $s_i(t)$ in the signal constellation diagram. ***(03)***

4B. A binary sequence 1011 is transmitted using the shift keying technique that occupies maximum channel bandwidth.

(i) Sketch the waveform at the transmitter output.

(ii) With neat block diagram and necessary expressions explain the detection of symbol '0' at the receiver. ***(04)***

4C. Construct complete code tree of a convolution encoder with rate 1/2, constraint length 2 as shown in Figure Q4C. Trace the coded vector for the input sequence (101). ***(03)***

5A. For a (3,1,2) convolution encoder the generator polynomial coefficients (1,1), (1,0) and (0,1)

a) Draw the convolution encoder using modulo 2 adders and shift registers.

b) Find the coded output for the input sequence (11010) using the same.

c) Represent and verify the generated coded output using state diagram. ***(04)***

5B. For a (7,3) linear block code the parity bits are $b_0=m_1$; $b_1=m_1 \oplus_2 m_2$; $b_2=m_1 \oplus_2 m_2$; $b_3=m_2$. Consider the last bit in the code vector to be m_2. If the received sequence is [1101011] then evaluate the syndrome vector. If received sequence is erroneous then find the location of error ***(03)***

5C. Describe the satellite uplink model with block diagram. ***(03)***

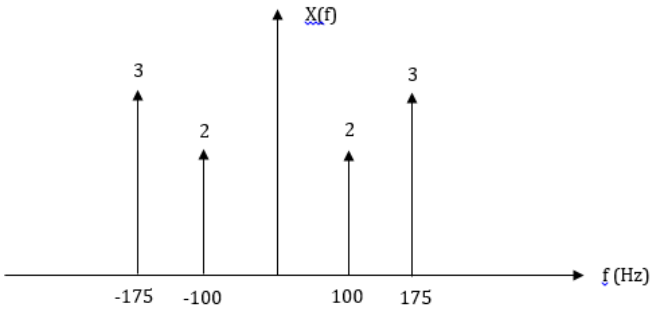

Figure Q3A

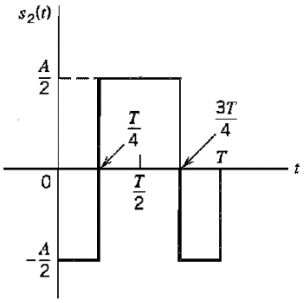

Figure Q3B

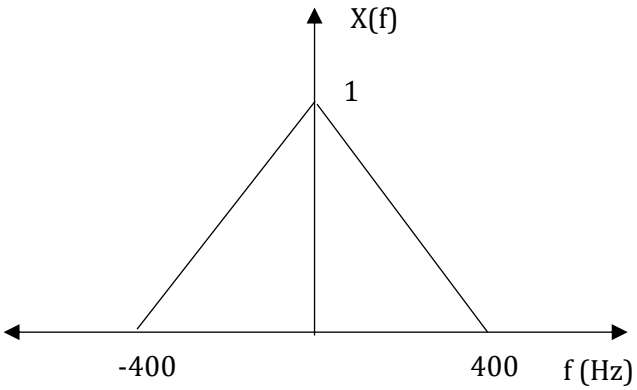

Figure Q3C

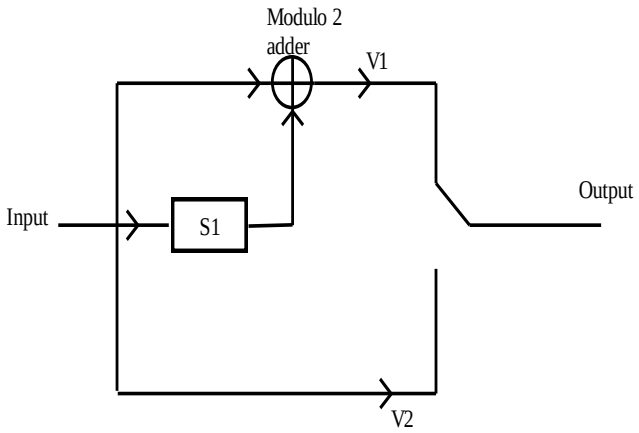

Figure Q4C

Table 1. Bessel function table

Modulation index	Sideband																
	Carrier	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
0.00	1.00																
0.25	0.98	0.12															
0.5	0.94	0.24	0.03														
1.0	0.77	0.44	0.11	0.02													
1.5	0.51	0.56	0.23	0.06	0.01												
2.0	0.22	0.58	0.35	0.13	0.03												
2.41	0	0.52	0.43	0.20	0.06	0.02											
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	0.01										
3.0	−0.26	0.34	0.49	0.31	0.13	0.04	0.01										
4.0	−0.40	−0.07	0.36	0.43	0.28	0.13	0.05	0.02									
5.0	−0.18	−0.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02								
5.53	0	−0.34	−0.13	0.25	0.40	0.32	0.19	0.09	0.03	0.01							
6.0	0.15	−0.28	−0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02							
7.0	0.30	0.00	−0.30	−0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02						
8.0	0.17	0.23	−0.11	−0.29	−0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03					
8.65	0	0.27	0.06	−0.24	−0.23	0.03	0.26	0.34	0.28	0.18	0.10	0.05	0.02				
9.0	−0.09	0.25	0.14	−0.18	−0.27	−0.06	0.20	0.33	0.31	0.21	0.12	0.06	0.03	0.01			
10.0	−0.25	0.04	0.25	0.06	−0.22	−0.23	−0.01	0.22	0.32	0.29	0.21	0.12	0.06	0.03	0.01		
12.0	0.05	−0.22	−0.08	0.20	0.18	−0.07	−0.24	−0.17	0.05	0.23	0.30	0.27	0.20	0.12	0.07	0.03	0.01