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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. (Full Time) - END SEMESTER EXAMINATIONS, MAY/JUNE 2024

ELECTRONICS & COMMUNICATION
IV Semester
EC 5402 COMMUNICATION THEORY

(Regulation 2019)

Time: 3hrs Max.Marks: 100

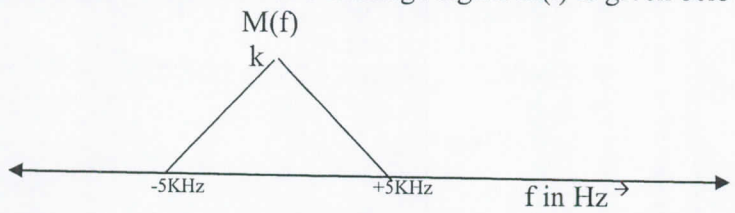
CO 1	Ability to apply transforms for signal modulation techniques
CO 2	Ability to develop the architectures of communication systems for analog modulation techniques
CO 3	Ability to explore the role of random process in communication systems.
CO 4	Ability to analyse the noise performance of analog communication receivers
CO 5	Learning the speech coding techniques and communication systems

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	Compare the features of AM, DSBSC and SSB.	2	1	L2
2	Outline a method of generation of DSBSC.	2	2	L1
3	A FM wave is generated by modulating a carrier with a message signal of bandwidth 5 KHz. Calculate the bandwidth of the FM signal if the modulation index is 6.	2	2	L2
4	Draw the block diagram of a FM Modulator and comment on the output frequency.	2	2	L1
5	Give the conditions satisfied by a Wide Sense Stationary Process.	2	3	L2
6	Give any two properties of the Autocorrelation Function	2	3	L2
7	Define the term 'Noise Figure' of an amplifier. What is the relation between Noise Temperature and Noise Figure.	2	4	L1
8	What do you understand by Pre-emphasis and De Emphasis in FM?	2	4	L4
9	What do you understand by Frequency Division Multiplexing?	2	5	L2
10	What are problems associated with Delta Modulation when the slope of the signal is 'very high' or 'very low'?	2	5	L4

PART- B (5 x 13 = 65 Marks)

Q. No	Questions	Marks	CO	BL
11 (a) (i)	The Fourier Transform of a message signal m(t) is given below:  Assume that the carrier is given by $c(t) = A\ \cos(2\pi f_c t)$. The message signal is m(t). Write down the time domain expression and the frequency domain expression (Fourier Transform) of the modulated wave, if the modulation used is a. DSBSC b. AM with Modulation Index '0.8' (assume m(t) =m_n(t)) Also, draw the Spectrum in each of these cases.	8	1	L4
(ii)	How is Coastas loop used in the demodulation of DSBSC?	5	2	L2
	OR			
11 (b) (i)	Derive the expression for the $(SSB)_{USB}$ in terms of m(t) and the Hilbert Transform of m(t). If m(t) = 2 $\cos(300\pi t)$ and the carrier wave is $c(t) = 50\ \cos(8000\pi t)$, give the expression for the $(SSB)_{USB}$ in the time domain and the frequency domain. Also, draw the spectrum of the modulated wave.	8	1	L4
(ii)	Argue that SSB can be used if the message is a speech signal and not a video signal.	5	2	L2
12 (a)	Draw the block diagram of a PLL and explain FM demodulation using the PLL with suitable Mathematical treatment.	13	2	L4
	OR			
12 (b)	Write down the time domain expression and obtain the frequency domain expression (Fouries series) of the FM wave modulated by a single sinusoid. A FM signal is generated by modulating the carrier signal $\boldsymbol{c(t) = 60\cos(220 * 10^6\pi t)}$ with the message signal $\boldsymbol{m(t) = 15\cos(6 * 10^3\pi t)}$. The FM modulator has a frequency sensitivity of 1**KHz/Volt**. Plot the spectrum of the FM wave (You can use Table 1).	13	2	L4
13 (a) (i)	Give an example of a Random variable & Random Process. Bring out the difference between a Random Variable and a Random Process and the way in which they are statistically described. Define an Ergodic Process. Give the expressions for the mean and the Autocorrelation of an Ergodic Process.	8	3	L4

(ii)	State the conditions satisfied by the two random variables X & Y which are a. Uncorrelated b. Statistically independent Assume that P & Q are uncorrelated Random variables of mean 7 and -2 and variance 25 and 36 respectively. V = P+Q Z=5P R=P- 4 Find the mean and the variance of V,Z and R.	**5**	3	L4
	OR			
13 (b) (i)	Draw the Autocorrelation Function and Power Spectral Density of White Noise. Assume that the White noise process is passed through a Low Pass Filter with H(f). $H(f) = 2\ for\ \ \lvert f\rvert < B$ $= 0\ for\ \lvert f\rvert > B$ Draw the power spectral density of the output Random Process. What is the power in the output Random Process?	**8**	3	L4
(ii)	Assume A and f are constants and Φ is a Random Variable. Y(t) (Random Process) is a sinusoidal signal with Random Phase given by $Y(t) = A\ \cos(2\pi ft + \Phi)$ The pdf of Φ is given by. $f_\Phi(\Phi) = \frac{1}{2\pi}, \quad 0 \leq \Phi < 2\pi$ Find the Mean and Autocorrelation function of Y(t)	**5**	3	L4
14 (a) (i)	State two important properties of Narrowband Noise. Assume that a DSBSC receiver receives a DSBSC signal corrupted by Additive White Gaussian Noise. Calculate the SNR at the output of the receiver.	**10**	4	L4
(ii)	A receiver has three amplifiers of different gains and Noise figures cascaded to achieve the required gain. Write the expression for the Overall Gain, Noise Figure and Noise Temperature of the cascaded system. What is the important inference that you draw from the expression?	**3**	4	L4
	OR			
14 (b) (i)	Derive the expression for the (SNR) at the output of a FM receiver.	**10**	4	L4
(ii)	In a FM system, comment on the role played by the FM modulation Index 'β'.	**3**	4	L4
15 (a)	Derive the expression for the Mean Squared error at the output of an quantizer. Derive the expression for the $(SNR)_Q$ at the output of an Uniform Quantizer fed with samples with a Gaussian pdf of Zero mean and variance σ^2.	**13**	5 5	L3
	OR			
15 (b)	With a suitable block diagram explain a DPCM encoder and decoder. With suitable Mathematical derivation explain the reduction in bit rate achieved by a DPCM as compared to a PCM operating at the same $(SNR)_Q$. How is Adaptive Prediction implemented in an ADPCM?	**13**	5 5	L3

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16. (i)	Draw an envelope detector which is capable of demodulating an AM of carrier frequency 455 KHz and maximum bandwidth 10 KHz.	3	2	L5
(ii)	A receiver is fed with a FM signal of carrier frequency 2 MHz. The message signal that modulated the FM is of bandwidth 2 KHz and the FM modulation index is 4. Suggest a scheme to demodulate the FM signal received using the AM envelope detector mentioned in (i) (you can use additional functional blocks as required. Assume that there is no PLL available for FM demodulation).	12	1	L5

TABLE 1 TABLE OF BESSEL FUNCTION VALUES

n	$\beta = 0.1$	$\beta = 0.2$	$\beta = 0.5$	$\beta = 1$	$\beta = 2$	$\beta = 5$	$\beta = 8$	$\beta = 10$
0	0.997	0.990	0.938	0.765	0.224	−0.178	0.172	−0.246
1	0.050	0.100	0.242	0.440	0.577	−0.328	0.235	0.043
2	0.001	0.005	0.031	0.115	0.353	0.047	−0.113	0.255
3				0.020	0.129	0.365	−0.291	0.058
4				0.002	0.034	0.391	−0.105	−0.220
5					0.007	0.261	0.186	−0.234
6					0.001	0.131	0.338	−0.014
7						0.053	0.321	0.217
8						0.018	0.223	0.318
9						0.006	0.126	0.292
10						0.001	0.061	0.207
11							0.026	0.123
12							0.010	0.063
13							0.003	0.029
14							0.001	0.012
15								0.004
16								0.001