Analog and Digital Communication (CT214)

1st In-Semester Examination

Closed Books and Closed Notes Examination

Date: 9 February 2016   **Time: 4:30 to 6:30 pm**

Answer all questions

Section A

Please write all answers of this section only in space given in this question paper.

1.   Name three essential parts of any communication system?   (3 marks)

2.   What is the important characteristic of full-deplex system regarding transmission channel?   (2 mark)

3.   Name two fundamental limitations of information transmission by electrical means using a communication system?   (2 marks)

4.   In the electromagnetic spectrum, what VHF stands for?   (2 marks)

5.   In the electromagnetic spectrum, what LF stands for?   (2 marks)

6. What is the full form of FDM and TDM in communication systems?   (3 marks)

7. A weather forecast gives following information.
    (a) There will be scattered rainstroms.
    (b) There will be a tornado?
    State whether (a) or (b) has highest amount of information.   (1 mark)

8. What is the full form of DSBFC, DSBSC, SSBSC and VSB in amplitude modulation?
                                                                              (6 mark)

9. An information source has M discrete messages which are different and independent.
    State condition for maximum entropy. Also, give probability of each message. (4 mark)

10. State the frequency ranges of AM broadcast services in medium-wave band and FM
    broadcasting in VHF band?   (2 mark)

11. In case of sinusoidal FM, if transmitted FM power and carrier power are P_T and P_C,
    respectively. State relationship between P_T and P_C.   (2 mark)

12. In case of FM modulated signals, define deviation ratio (D) in terms of maximum
    frequency deviation (ΔF) and highest modulating frequency (F_m). What is the maximum
    deviation ratio allowed for commercially broadcast FM?   (4 mark)

13. What is the full form of PM modulation?   (1 mark)

14. In analog TV transmission, what modulations are used for audio and video signals?
(2 mark)

15. How many sidebands are present in case of AM and FM broadcast services?
(2 marks)

Section B
Please write all answer of this section only in regular answer book (8 pages long).

1. (a) State and explain 5 benefits of modulation in communication systems.

(5 marks)

(b) Derive an expression for sinusoidal AM signal e(t) in terms peak amplitude of carrier wave, $E_{c\,max}$, frequency of carrier wave (f_c), peak amplitude of modulating signal $E_{m\,max}$, frequency of modulating signal (f_m) and modulation index (m). Sketch waveforms of sinusoidal AM for m = 0.5 and m = 1. Also, find frequency spectrum of AM modulated signal, (5 marks)

(c) What are advantages and disadvantages of SSB AM transmission as compared to standard AM and DSB AM? (3 marks)

(d) A carrier wave of frequency 10 MHz and peak amplitude value of 10 V is amplitude modulated by a 5-kHz sine wave of amplitude 6V. The load resistance is 20 Ω. Determine the modulation index, power in each side band, carrier power and total AM power. Draw the spectrum of AM wave. (5 marks)

(e) What is the bandwidth of AM signal if the highest frequency of modulating signal is $f_{m\,max}$ and carrier frequency is f_c? (2 marks)

2. (a) Derive an expression for sinusoidal FM voltage V. Assume carrier signal of amplitude A and angular frequency ω_c, modulating signal of amplitude V_m and

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angular frequency ω_m, modulation index m_f and maximum frequency deviation δ.

(5 marks)

(b)   An FM modulator is operating with peak frequency deviation (δ) of 20 kHz, carrier frequency (f_c) of 100 kHz, amplitude of carrier signal is 10 V, and modulating frequency (f_m) of 5 kHz. Determine minimum bandwidth required using Bessel Function table. Sketch the frequency spectrum. Also, calculate minimum bandwidth required using Carson's rule.   (5 marks)

(c)   Discuss all advantages and disadvantages of FM and AM modulation systems. What are the advantages and disadvantages of FM and AM broadcast services.

(6 marks)

(d)   Compare PM and FM signals in terms of instantaneous phase $\phi(t)$ and instantaneous frequency f(t).   (4 marks)

3. (a)   Define Shannon's theorem. Assume that there are M discrete messages. R denotes information rate and C denotes channel capacity.   (3 marks)

(b)   Define Shannon-Hartley theorem for gaussian channel relating bandwidth (B), signal-to-noise-ratio (S/N) and channel capacity (C).   (3 marks)

(c)   Derive an expression for entropy $H = \sum_{k=1}^{M} p_k \log_2\left[\frac{1}{p_k}\right]$. Assume that there are M different and independent messages $m_1, m_2, \ldots$ with probabilities of occurrence $p_1, p_2, \ldots$ (3 marks)

(d)   Messages Q_1, Q_2, Q_3, Q_4 and Q5 occur with probabilities ½, ¼, 1/8, 1/16 and 1/16, respectively. Calculate average information per message. Fine information rate if the message rate is 1500 per second. If the channel capacity is 2500 bits/second, what will be the probability of error for transmission over communication channel?

(6 marks)

(e)   A CRT terminal is used to enter alphanumeric data into a computer. The CRT is connected to the computer through a voice grade telephone line having a usable bandwidth of 3000 Hz and output signal-to-noise-ratio (S/N) of 10 dB. Assume

that the terminal has 128 characters and that can be sent from the terminal consists of independent sequences of equiprobable characters. (i) Find the capacity of the channel. (ii) Find the maximum (theoretical) rate at which data can be transmitted from the terminal to the computer without errors. (5 marks)

TABLE 5-2   Bessel Functions of the First Kind

x								n or Order									
(m_f)	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	J_{15}	J_{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	—	—	—	—	—	—	—	—	—	—	—	—
2.5	−0.05	0.50	0.45	0.22	0.07	0.02	—	—	—	—	—	—	—	—	—	—	—
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	—	—	—	—	—	—	—	—
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	—	—	—	—	—
9.0	−0.09	0.24	0.14	−0.18	−0.27	−0.06	0.20	0.33	0.30	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	0.31	0.29	0.20	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
15.0	−0.01	0.21	0.04	−0.19	−0.12	0.13	0.21	0.03	−0.17	−0.22	−0.09	0.10	0.24	0.28	0.25	0.18	0.12