UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007

April 2007

EEE 530 – COMMUNICATION CIRCUITS AND SYSTEMS

Duration: 3 hours

Please check that this examination paper consists of SEVEN pages of printed material before you begin the examination.

This paper contains SIX questions.

Instructions: Answer **FIVE (5)** questions.

Answer to any question must start on a new page.

Distribution of marks for each question is given accordingly

All questions must be answered in English.

Use SI systems of units
Assume suitable data where necessary

1. (a) Describe the advantages and disadvantages of direct conversion receiver structures over superheterodyne receivers. Use block diagrams to describe them.

(20%)

(b) A radio receiver is tuned to receive a signal at 880 MHz. It uses an IF frequency of 88 MHz. What is the frequency of the image frequency that could be received by this system? Describe three methods that could be used to minimize reception of an image signal.

(40%)

(c) The double-conversion receiver in Figure 1 below employs two IF filters. Specify the required local oscillator frequncies (f_1 and f_2) for a receiver covering the 1-MHz to 40 MHz range. The center frequency of the first IF filter is 60 MHz, and that of the second IF filter is 15 MHz.

(40%)

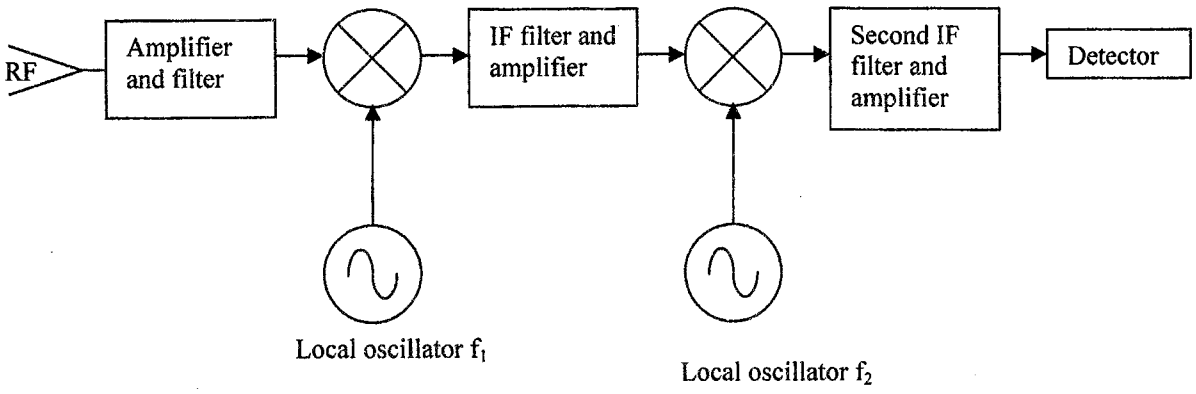

Figure 1

2. (a) Describe 3 configuration of mixers using block diagrams to illustrate them (20%)

(b) A double-sided signal of the form $v_{RF} = V_{RF}[\cos(\omega_{LO}-\omega_{IF})t + \cos(\omega+\omega_{IF})t]$ is applied to a mixer with an LO voltage given by $v_{LO}(t) = \cos 2\pi f_{LO}t$. Derive the output of the mixer after low pass filtering. (30%)

(c) The frequency synthesizer of Figure 2 below provides 400 output frequencies equally spaced by 10 kHz. The output frequencies extend from 144.0 to 148.0 MHz. The input frequency, f_{ref} equals 10 kHz, and the high-frequency oscillator has a frequency f_H equal to 100 MHz.

(i) Calculate the minimum and maximum values required for the ÷N counter.

(ii) What is the output frequency if N=4603?

(iii) What changes need to be made if it is desired to produce 900 frequencies equally spaced by 4 kHz?

(50%)

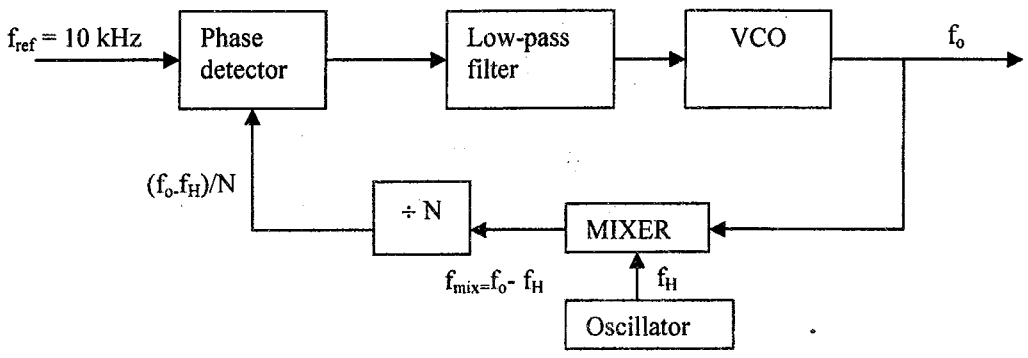

Figure 2

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3. (a) An AM signal in which the carrier is modulated 65% contains 1600 W at the carrier frequency. Determine the power content of the upper and lower sidebands for this percent modulation. Calculate the power at the carrier and the power content of each sidebands when the percent modulation drops to 40%.

(40%)

(b) Explain using block diagrams what is an AM and FM transmitter .

(20%)

(c) A carrier is frequency modulated by 3 kHz sine wave resulting in an FM signal having a miximum frequency of 110.47 MHz and a minimum frequency of 109.84 MHz.

(i) Find the carrier swing
(ii) Calculate the carrier frequency
(iii) What is the frequency deviation of the FM signal
(iv) Determine the modulation index of the FM signal

(40%)

4. (a) The Generator Matrix of a (7, 4) linear block code is given by

$$\mathbf{G} = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$

...5/-

Determine the error detection and error correction capabilities of the code. Note that a linear block code with minimum distance d_{min} can correct up to $[(d_{min}-1)/2]$ errors and detect up to $[d_{min}-1]$ errors in each code word. $[(d_{min}-1)/2]$ denotes the largest integer no greater than $(d_{min}-1)/2$.

(40%)

(b) A signal $m_1(t)$ is band limited to 3.6 kHz and three other signals $m_2(t)$ $m_3(t)$ and $m_4(t)$ are band limited to 1.2 kHz each. These signals are to be transmitted by means of time division multiplexing

(i) Set up a scheme for accomplishing this requirement with each signal sampled at its Nyquist rate.

(ii) What must be the speed of commutator in samples per second?

(iii) If each sample is binary coded with ten bits, determine the output bit rate.

(iv) Determine the minimum transmission band width required.

(40%)

(c) A discrete source S_1 without memory has an alphabet size of two with symbol probabilities 0.4 and 0.6. A new source S_2 of alphabet size four is constructed from S_1 by combining two symbols. Determine the entropies of S_1 and S_2 and comment on the results.

(20%)

5. (a) A discrete memory-less source has an alphabet size of six with symbol probabilities as 0.1, 0.1, 0.1, 0.1, 0.2, and 0.4. Construct a Huffman code for the source and calculate its efficiency.

(50%)

(b) In a CDMA system using Direct Sequence Spreading the baseband (narrow band) signal A is spread using a PN code B to give the composite wideband signal C. Show that the baseband signal A can be correctly recovered by de-spreading C with the same PN code B.

(50%)

6. (a) Construct the standard array for the decoder of a (6, 3) linear block code whose generator matrix is given by

$$\mathbf{G}=\begin{bmatrix}1 & 0 & 0 & 1 & 1 & 0\\ 0 & 1 & 0 & 0 & 1 & 1\\ 0 & 0 & 1 & 1 & 0 & 1\end{bmatrix}$$

With the help of examples explain how such an array is used to decode the message block from a noise corrupted received code block.

(50%)

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(b) Explain what you understand by "Channel Capacity" of a cellular mobile system. Consider a cell having 48 channels and a grade of service GOS of 2%. The channels are further sectored into three as shown in Figure 1. Determine the trunking efficiency in each case and comment on your answers. For 2% GOS, take the traffic intensity for 48 channels as 38.4 Erlangs and for 16 channels as 9.83 Erlangs.

(50%)

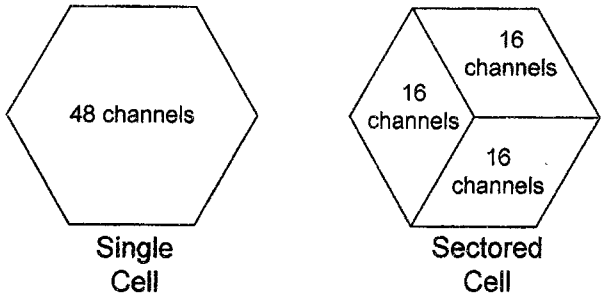

Figure 1

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