

OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SEMESTER II EXAMINATIONS 2000/2001

THIRD YEAR ELECTRONIC ENGINEERING
THIRD YEAR ELECTRONIC AND COMPUTER ENGINEERING

EE308 SIGNALS AND COMMUNICATIONS

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Duration of Examination: TWO hours
Instructions: Answer THREE questions

1.

(a)

(i) Define both the modulation index m and the efficiency η of a normal AM signal. [3 marks]

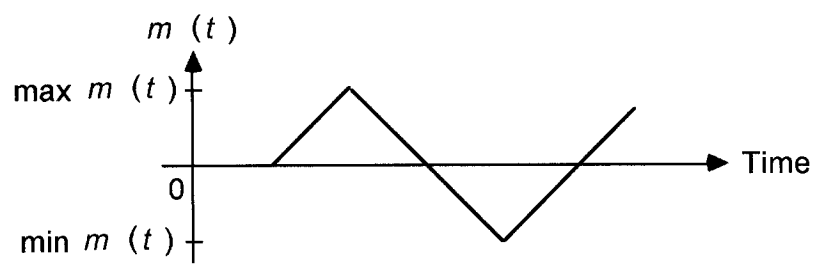


Fig. 1

(ii) Fig. 1 shows a modulating or message signal $m(t)$. Sketch an example of a normal AM modulated signal for each of the following three cases. [6 marks]

- $m < 1$
- $m = 1$
- $m > 1$

(iii) If $m(t)$ has a maximum value of 2 and a minimum value of -2, what are the range of values of A (the amplitude of the carrier signal) that will cause *overmodulation* of a normal AM signal? [2 marks]

(b)

(i) Draw the circuit diagram for a normal AM envelope detector, and explain with the aid of a waveform diagram how a message signal is recovered from a modulated signal using this circuit. [5 marks]

(ii) Why is it not possible to use an envelope detector to demodulate DSB signals? [2 marks]

(iii) What sacrifice must be made when using an envelope detector to demodulate SSB or VSB signals? [2 marks]

[cont'd]

2.

- (a) If a modulating signal has a bandwidth of F_m , draw a table showing the relative bandwidth requirements for the following types of amplitude modulated signals. [4 marks]
- Normal AM (DSB-LC)
 - DSB (DSB-SC)
 - SSB
 - VSB
- (b) What are the relative advantages and disadvantages of the filter method vs. the phasing method for SSB modulation? [4 marks]

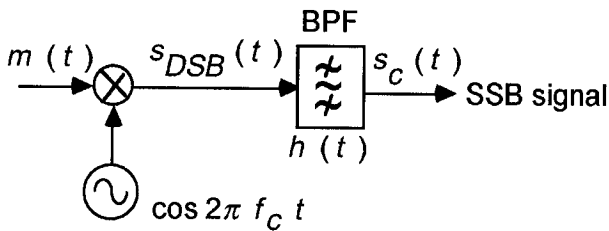


Fig. 2

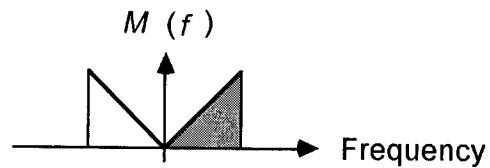


Fig. 3

- (c) Fig. 2 shows a block diagram for SSB modulation using the filter method. If the spectrum of the modulating signal $m(t)$ is as shown in Fig. 3, and the upper side band is being transmitted on a carrier frequency of f_c , sketch the spectra for $S_{DSB}(f)$, $|H(f)|$ and $S_c(f)$. [6 marks]
- (d) Show how the spectrum $S_c(f)$ would change if a VSB modulation scheme was implemented instead of SSB. [4 marks]
- (e) Give an everyday example of where (i) an SSB signal and (ii) a VSB signal are used. [2 marks]

3.

- (a)
- (i) Define any three of the following five terms as they relate to general angle modulated signals. [3 marks]
- Instantaneous angular frequency
 - Instantaneous frequency
 - Instantaneous frequency deviation
 - Peak frequency deviation
 - Instantaneous phase deviation
- (ii) Show that it is possible to generate a PM signal using a frequency modulator, and an FM signal using a phase modulator. [7 marks]
- (b) Explain using diagrams where necessary how the frequency discrimination method can be used to demodulate the angle modulated signal $s_c(t)$:

$$s_c(t) = A \cos \theta(t)$$

where:

$$\theta(t) = 2\pi f_c t + \phi(t)$$

for both PM and FM. [10 marks]

[cont'd]

4.

- (a) Define the modulation index β and the peak frequency deviation Δf for FM with a sinusoidal modulating signal. [2 marks]
- (b)
- (i) An angle modulated signal using FM has an angular carrier frequency $\omega_c = 2000$ rad/s, and a peak frequency deviation of 500 Hz. If the modulating signal is given by the equation:

$$f(t) = 30 \cos(160\pi t)$$

determine the bandwidth of the FM signal using Carson's rule. [6 marks]

- (ii) What type of angle modulated signal results if $\beta \ll 1$, and what is the bandwidth of such a signal? [2 marks]
- (c) With the aid of a block diagram, describe the steps involved in the indirect method for generating a wideband FM signal. [8 marks]
- (d) Fig. 4 illustrates the direct method of generating a wideband FM signal. What is the function of the empty block in the middle, and what is it called? [2 marks]

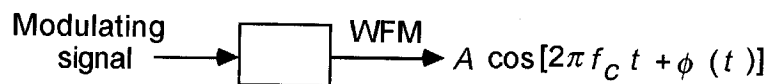


Fig. 4

5.

- (a)
- (i) Define a band limited signal. [2 marks]
- (ii) State the sampling theorem. [2 marks]
- (iii) What is the Nyquist sampling rate? [1 mark]
- (iv) What is meant by interpolation? [1 mark]

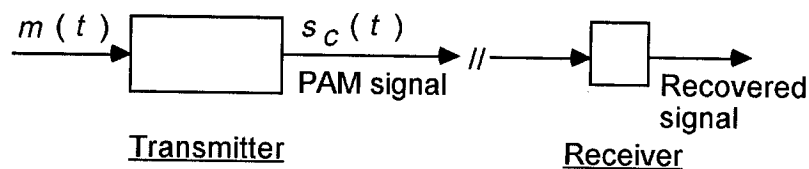


Fig. 5

- (b) What is PAM? Name the empty blocks in the PAM system shown in Fig. 5. [3 marks]
- (c) Table 1 shows the practical sampling frequency values for audio and broadcast signals. Complete the values missing from this table in your answer book. [3 marks]

Signal	f_m	Minimum f_s	Practical f_s
Audio	3.3 kHz		
Music	20 kHz		
TV	4 MHz		

Table 1

- (d) One of the basic problems in communication engineering is the design of a pulse communication system which allows signals from many users to be transmitted simultaneously over a single communication channel. Explain using diagrams what TDM is and how it can be used as a solution to this problem. [8 marks]