

1 Hr. 15 Min.  
Closed Book

TCOM 370  
Exam 1

Feb. 12, 1998  
One Info. Sheet Allowed

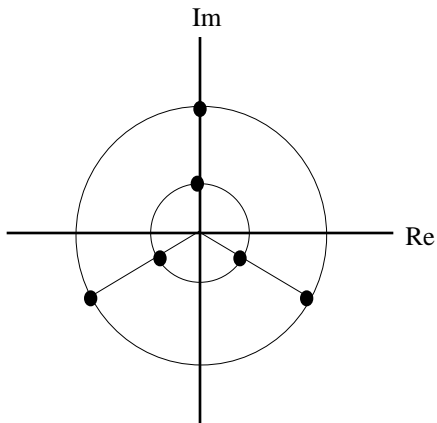
*All problems equally weighted*

**Problem 1**

- (a) Define the term "full duplex" in describing data transmission links.
- (b) Give two methods for achieving full duplex in data transmission over phone lines using modems; explain *briefly* the disadvantage or special requirement for each.

**Problem 2**

An engineer designs the symmetric 6-point QAM constellation given below:



- (a) How many different phases are produced in this constellation?
- (b) How many binary digits can be encoded onto each *individual* symbol or pulse from this constellation? Can you suggest a way to improve this number (bits/pulse) for this constellation?

**Problem 3**

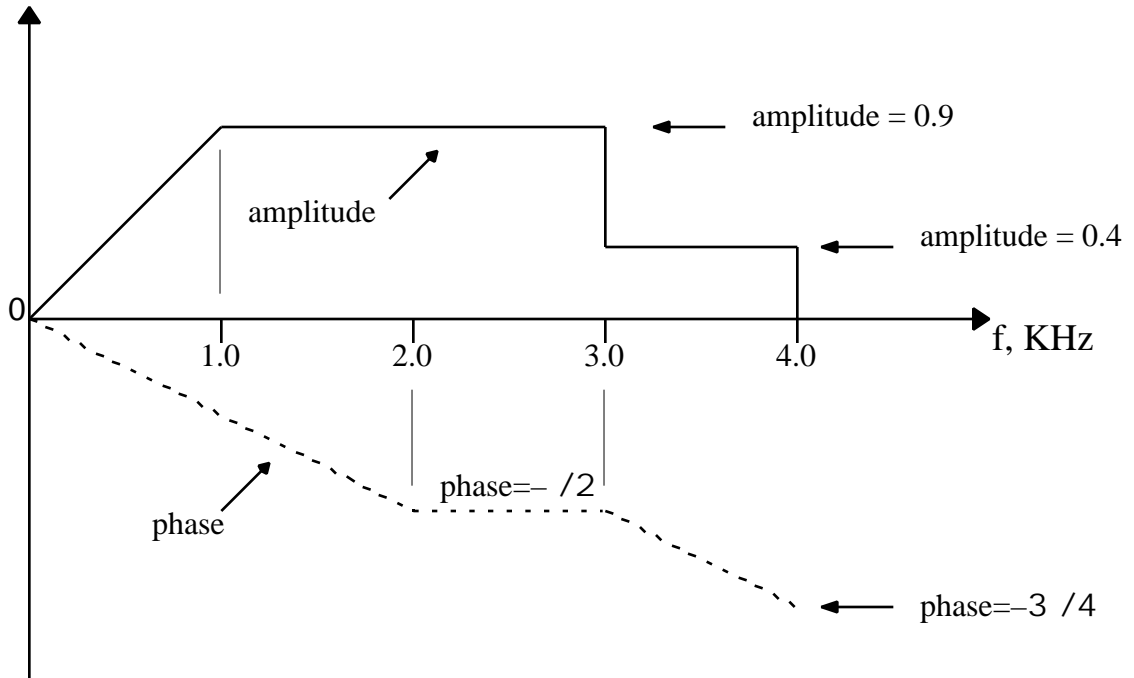
Shannon's formula for the ultimate capacity  $C$  of a communication link with  $W$  Hz bandwidth is  $C=W \log_2(1 + \frac{S}{N})$  bps, where  $\frac{S}{N}$  is the ratio of signal power to noise power at the receiver.

A link is to be operated at a bandwidth efficiency of  $B=9$ , i.e. at a rate of 9 bps for each Hz of bandwidth. Obtain the *minimum SNR* required at the receiver to allow, in theory, error-free transmission with this bandwidth efficiency. Express your answer in dB's.

**Problem 4**

The frequency response characteristics of a channel is shown below:

Frequency Response



Identify the frequency band, or bands, if any, over which

- (i) there is no amplitude distortion;
- (ii) there is no delay distortion;
- (iii) over which *distortionless transmission* is possible.

**Problem 5**

A 100 KHz carrier  $\cos(2 \cdot 100 \cdot 10^3 \cdot t)$  is *amplitude modulated* by a signal  $s(t)$  given as

$$s(t) = 10 \cos(2 \cdot 10^3 \cdot t) + 8 \cos(4 \cdot 10^3 \cdot t) + 6 \cos(10 \cdot 10^3 \cdot t)$$

What frequencies are contained in the modulated carrier? *Sketch* its amplitude spectrum.

**Problem 6**

Data is to be transmitted in one direction on a communication link with a transmission frequency band between 500 Hz and 2500 Hz. The transmission scheme is binary FSK modulation, using almost rectangular pulses of width  $\tau$  secs. The two carrier frequencies ( $f_1$  and  $f_2$ ) are 1300 Hz and 1700 Hz.

- (a) Determine if pulses of width  $\tau = 2$  ms (which is  $2 \times 10^{-3}$  secs.) can be used.
- (b) What is the highest data rate that can be achieved ?