THE UNIVERSITY OF ADELAIDE

EXAMINATION FOR THE DEGREE OF B.E.

COMMUNICATION THEORY (7192)

June 2000

Time: ONE hour and FIFTEEN minutes

In addition, candidates are allowed ten minutes before the examination begins to read the paper.

The use of calculators is permitted, this equipment to be supplied by the candidate. No pre-recorded material nor calculator instruction book is permitted, and calculators with remote communication links will be barred from the examination room.

Attempt ALL THREE questions.

Questions 1 and 2 carry twenty marks each and Question 3 carries 10 marks. Marks for part questions are indicated in brackets.

ANSWERS TO QUESTIONS SHOULD BE EXPRESSED CLEARLY AND WRITTEN LEGIBLY. THESE ASPECTS OF PRESENTATION WILL BE TAKEN INTO ACCOUNT IN ASSESSMENT.

Question 1 follows on page 2.

Question 1

a) A normalized message signal $m_n(t)$ has a bandwidth of 10 kHz and its power content is 0.5 W. The carrier $c(t) = A\cos(2\pi f_o t)$ has a power content of 200 W.

What will be the bandwidth and power content of the modulated signal if the modulation scheme used is:

i) Double-sideband suppressed carrier (DSB-SC) amplitude modulation ?
ii) Conventional amplitude modulation (AM) with modulation index of 0.6.
iii) Frequency modulation (FM) with frequency deviation constant k_f = 50000 Hz/V.

[10 marks]

b) Design (in block diagram form) an Armstrong indirect FM modulator to generate an FM carrier with a carrier frequency of 98.1 MHz and peak frequency deviation of 75 kHz. A narrow-band FM generator is available at a carrier frequency of 100 kHz and peak frequency deviation of 10 Hz. Assume that an oscillator with adjustable frequency in the range 10 to 11 MHz and frequency multipliers are also available.

[10 marks]

Question 2 follows on page 3

Question 2

a) A voice band telephone channel passes the frequencies in the band from 300 to 3300 Hz. It is desired to design a modem that transmits at a symbol rate of 2400 symbols/second, with the objective of achieving 9600 bits/second with zero inter-symbol interference (ISI).

(i) Select and sketch an appropriate quadrature amplitude modulation QAM signal constellation.

(ii) On your sketch in (i) above, show optimum decision boundaries for the detector, assuming that the SNR is sufficiently high so that errors only occur between adjacent points.

[8 marks]

b) Consider 4-PSK and 8-PSK signal constellations respectively with radii of r_1 and r_2 .

(i) Sketch each constellation.

(ii) Determine the respective radii when the required distance between two adjacent points in each of the constellations is d.

(iii) Use the results in b(i) above to determine the additional transmitted energy required in 8-PSK signal to achieve the same probability of error as the 4-PSK signal. Assume a high SNR, where the probability of error is determined by errors in selecting adjacent points.

[12 marks]

Question 3

A source generates symbols from a set {A, B, C, D, E, F, G, H} with respective probabilities as shown in the table below:

Symbol	Probabilities
A	0.512
B	0.128
C	0.128
D	0.128
E	0.032
F	0.032
G	0.032
H	0.008

i) Calculate the source entropy.

ii) Design a Huffman code for the source

iii) Calculate the coding efficiency of the Huffman code derived in (ii) above.

[10 marks]