SINGAPORE POLYTECHNIC **ET0930**

SAMPLE SEMESTER EXAMINATION **Paper 1**

Diploma in Electrical & Electronic Engineering (DEEE)
3rd Year FT

Instructions to Candidates:

1. The Singapore Polytechnic examination rules are to be complied with.

2. This paper consists of **TWO** sections:
   Section A: 5 short questions, 12 marks each
   Section B: 2 Long Questions, 20 marks each

3. **ALL** questions are **COMPULSORY**.

4. All questions are to be answered in the answer booklet.
   Start each question on a new page.

5. Fill in the Question Number, in the order that it was answered, in the boxes found on the front cover of the answer booklet under the column "Question Answered".

6. This paper consists of **12** pages, including 2 pages of Formula List and 4 pages of Complementary Error Function Table.

7. The question paper must be submitted together with the answer booklet at the end of this exam session.

SECTION A (5 Short Questions, 60 marks)

A1. A 2 V_{peak}, 15 kHz sinusoidal signal is fed into a frequency modulator with carrier of 200 kHz. The FM signal generated has a peak frequency deviation of 30 kHz.

(a) Determine the modulation index. (3 marks)

(b) Determine the conversion gain of the FM modulator. (2 marks)

(c) Using Carson's rule, find the bandwidth of the FM signal. (2 marks)

(d) Sketch the spectrum of the FM signal. You only need to label the frequency of each component. (5 marks)

A2. (a) State two main differences between natural and flat top sampling. (6 marks)

(b) A PCM system employs a uniform 4-bit quantiser/encoder. The maximum permissible input voltage to the quantiser is 10 volts peak-to-peak. Calculate the signal-to-quantisation noise ratio (in dB) for the input signal, v(t) = 4 Sin ωt. (6 marks)

A3. A uniform mid-riser 3-bit quantiser has maximum and minimum inputs from +2.8V to -2.8V respectively.

(a) Calculate its step size, q. (2 marks)

(b) Draw the input-output characteristic of the quantiser. (5 marks)

(c) Calculate its signal-to-quantisation noise ratio (in dB). (3 marks)

(d) Determine the quantised voltage for a dc input of -1.6 V. (2 marks)

A4. A baseband digital communication system transmits random equiprobable binary signals. The transmission channel is affected by additive white Gaussian noise (AWGN) of rms values of 1 mV. The receiver is a simple comparator circuit. Assume that the line code used is of the form shown in Figure A4.

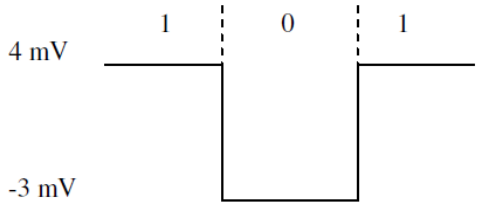


Figure A4

(a) Determine the value of the threshold voltage V_T to minimize the probability of bit error. (2 marks)

(b) Calculate the probability of bit error. (5 marks)

(c) If 10^5 bits are transmitted in each block of message, on average how many error bits will be received per block? (3 marks)

(d) What are the two main causes of signal degradation in the communication channel of a digital communication system? (2 marks)

A5. Binary data at rate 8 kb/s is transmitted over a passbank channel using BPSK. The carrier amplitude at the receiver is 12 mV, and the double-sided power spectral density of the channel AWGN is 1 nanowatt/Hz.

(a) Sketch a clearly labelled diagram of a BPSK transmitter. (2 marks)

(b) Calculate the bit error rate, assuming that an integrate-and-dump correlation receiver is used. (4 marks)

(c) If the carrier frequency is 16 kHz, draw the BPSK waveform for a bit sequence of 1010. (6 marks)

SECTION B (2 Long Questions, 40 marks)

B1. Consider the system in Figure B1.1, where $x(t) = \frac{1}{2} - \frac{1}{\pi}\sum_{n=1}^{\infty}\frac{\sin n4000\pi t}{n}$ is the input signal of a Low Pass Filter. p(t) is an ideal impulse sampling train which samples x(t) such that there is a guardband of 2 kHz. y(t) is the sampled signal.

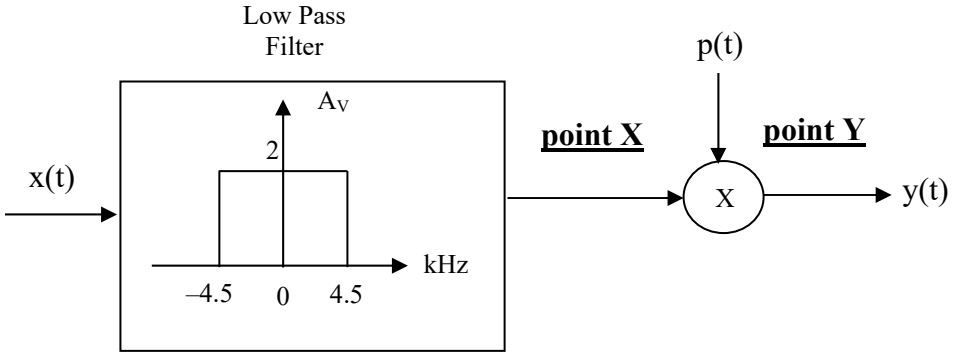
(a) Sketch the double-sided amplitude spectrum of x(t) up to the 4^{th} harmonic. (5 marks)

(b) State sampling theorem I. (2 marks)

(c) Determine the frequency of p(t). (3 marks)

(d) Sketch spectrum of p(t) for a frequency range of ±15 kHz. (3 marks)

(e) Sketch the amplitude spectrum of the sampled signal, y(t), for a frequency range of ±15 kHz. (7 marks)



B2. The received signal at an optimum receiver is in the form of a polar NRZ waveform of amplitude of ±5 mV with a data rate of 1200 bps. The AWGN channel noise has a single-sided power spectral density of 2×10^{-9} W/Hz. Assume that the bits of the source binary sequence are independent and equiprobable.

(a) Sketch the block diagram of an optimum receiver. (6 marks)

(b) Sketch the unit impulse response of the matched filter. Show your working. (8 marks)

(c) Calculate the probability of bit error, P_e. (6 marks)

**** End of the Paper ****