

## 1999 Paper 9 Question 11

### Information Theory and Coding

What class of continuous signals has the greatest possible entropy for a given variance (or power level)? What probability density function describes the excursions taken by such signals from their mean value? [4 marks]

What does the Fourier power spectrum of this class of signals look like? What is notable about the entropy of this distribution of spectral energy? [4 marks]

An error-correcting Hamming code uses a 7-bit block size in order to guarantee the detection, and hence the correction, of any single bit error in a 7-bit block. How many bits are used for error correction, and how many bits for useful data? If the probability of a single bit error within a block of 7 bits is  $p = 0.001$ , what is the probability of an error correction failure, and what event would cause this? [4 marks]

Suppose that a continuous communication channel of bandwidth  $W$ , which is perturbed by additive white Gaussian noise of constant power spectral density, has a channel capacity  $C$ . Approximately how much would  $C$  be degraded if suddenly the added noise power became 8 times greater? [4 marks]

You are comparing different image compression schemes for images of natural scenes. Such images have strong statistical correlations among neighbouring pixels because of the properties of natural objects. In an efficient compression scheme, would you expect to find strong correlations in the compressed image code? What statistical measure of the code for a compressed image determines the amount of compression it achieves, and in what way is this statistic related to the compression factor? [4 marks]