

## 1996 Paper 9 Question 11

### Information Theory and Coding

Consider a noiseless analog communication channel whose bandwidth is 10,000 Hz. A signal of duration 1 second is received over such a channel. We wish to represent this continuous signal exactly, at all points in its one-second duration, using just a finite list of real numbers obtained by sampling the values of the signal at discrete, periodic points in time. What is the length of the shortest list of such discrete samples required in order to guarantee that we capture all of the information in the signal and can recover it exactly from this list of samples? [5 marks]

Name, define algebraically, and sketch a plot of the function you would need to use in order to recover completely the continuous signal transmitted, using just such a finite list of discrete periodic samples of it. [5 marks]

Consider a noisy analog communication channel of bandwidth  $\Omega$ , which is perturbed by additive white Gaussian noise whose power spectral density is  $N_0$ . Continuous signals are transmitted across such a channel, with average transmitted power  $P$  (defined by their expected variance). What is the *channel capacity*, in bits per second, of such a channel? [10 marks]