

1. Obtain the achievable rate of a band-limited continuous-time channel with power constraint  $P$  and noise variance  $N_0$ .
  
2. According to the channel capacity of the band-limited continuous channel with power constraint  $P$  and noise variance  $N_0$  ( $C = W \log(1 + \frac{P}{N_0 W})$ ), answer to the following questions (Justify your answers).
  - (a) Do we always want more bandwidth?
  - (b) What can we do with infinite bandwidth?
  - (c) What is the minimum power  $P^*$  that is required to send 1 bit reliably?
  - (d) What can we do with infinite power?
  - (e) Plot the achievable rate as a function of bandwidth for the case with  $\frac{P}{N_0} = 1$ .
  
3. **(Extra-Graduates)** Show that among all continuous random variables with a given variance  $\sigma^2$ , the Gaussian random variable has the highest differential entropy.