

2 Topic: Information Sources

8. The signal at the output of an analogue information source $x(t)$ having a uniform pdf between ± 2 Volts, is passed through a half-wave and a full-wave rectifier circuits. Sketch and mathematically represent the pdfs of:

- (a) the original analogue information source, 5%
- (b) the output from the half-wave rectifier, 10%
- (c) the output from the full-wave rectifier. 10%
- (d) Determine
 - the mean value, and 15%
 - the rms value 15%

of the signals in cases (a),(b) and (c) above.

N.B.: Assume ideal diodes

9. Consider an analogue signal source $x(t)$ having a uniform amplitude probability density function

$$\text{pdf}_x(x) = \frac{1}{6} \text{rect} \left\{ \frac{x}{6} \right\}$$

- (a) Estimate the average power P_x of the signal $x(t)$. 10%
- (b) Find the differential entropy H_x of the signal source $x(t)$ 10%
- (c) Find $H_y - H_x$ 10%
 where H_y denotes the differential entropy of an analogue signal source $y(t)$ having a Gaussian amplitude probability density function with mean μ_y and $\sigma_y = \sqrt{P_x}$
- (d) What is the entropy power of the signal $x(t)$. 10%

10. A signal $g(t)$ having the pdf shown in Fig.1 is bandlimited to 4 kHz. The signal is sampled at the Nyquist rate and is fed through a 2-level quantizer. The transfer function of the quantizer is shown in Fig.2.

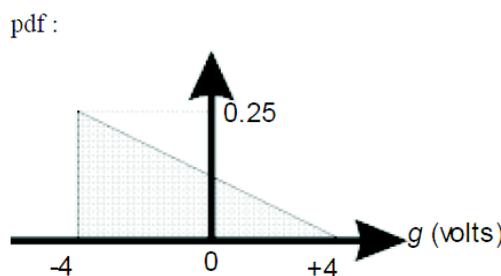


Fig. 1

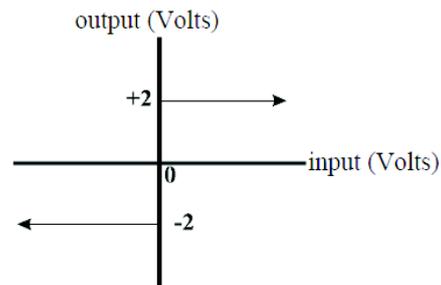
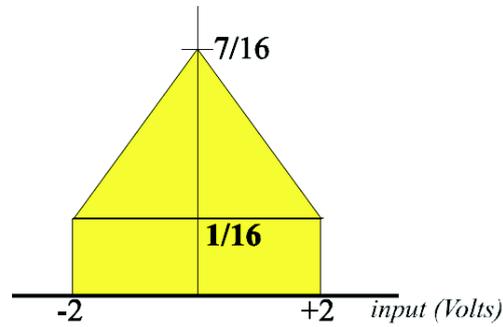


Fig. 2

Consider the output of the quantizer as the output of a discrete information source (X, \underline{p}) . Calculate:

- (a) the symbol rate r_X of the source (X, \underline{p}) . 10%
- (b) the amplitude pdf of the signal at the quantizer's output. Sketch this pdf. 10%
- (c) the rms value of the signal at the output of the quantizer. 10%
- (d) the entropy H_X 10%
- (e) the entropy of the source $(X \times X, \underline{J})$ (10%)

11. A signal $g(t)$ having the probability density function (pdf) shown below is sampled and fed through an 4-level quantizer.



Consider the output of the quantizer as the output of a discrete information source (X, \underline{p}) .

- | | |
|--|-----|
| (a) Calculate and sketch the pdf of the signal at the output of the quantizer. | 10% |
| (b) Calculate the rms value of the signal at the output of the quantizer. | 10% |
| (c) What is the ensemble of the source $(X \times X, \mathbb{J})$? | 10% |
| (d) Calculate the entropy $H_{X \times X}$ | 10% |