
Modality A: Midterm exam (sample 1)

- Each statement below concerns one part of a statement of the Midterm collection, and it may be worded differently from the collection. Clearly **select** (a) if the statement is true and (b) if it is false. Marks are +1 for a correct answer, −1 for a wrong answer, and 0 for no answer.
- No derivations or justifications are required, and none is marked.
- The exam **grade** is $R - W$, the number of right answers minus the number of wrong answers, over the 12 statements.
- No electronic devices and no printed or written material are allowed.
- The exam duration is **30 minutes**.

Name:

NIA or U:

1. The energy of a waveform is its inner product with itself, $E = \langle \phi, \phi \rangle$, a nonnegative real number.
 - (a) True
 - (b) False
2. Two waveforms with disjoint supports are orthogonal.
 - (a) True
 - (b) False
3. A signal band-limited to $|f| \leq W$ belongs to the space spanned by the orthonormal sampling waveforms $\phi_i(t) = \sqrt{2W} \operatorname{sinc}(2W(t - \frac{i}{2W}))$, with coefficients $x_i = \sqrt{2W} x(\frac{i}{2W})$.
 - (a) True
 - (b) False
4. A passband transmission of bandwidth W and duration T provides WT orthonormal complex waveforms, that is, WT channel uses.
 - (a) True
 - (b) False
5. Symbols sent as $\sum_{i=-\infty}^{\infty} X_i \phi(t - iT)$ are free of inter-symbol interference when the shifted waveforms $\phi(t - iT)$ are orthogonal, which holds if and only if the similarity function $R_{\phi\phi}(\tau)$ vanishes at every nonzero multiple of T .
 - (a) True
 - (b) False
6. For equiprobable symbols, the average symbol energy is the arithmetic mean of the squared moduli of the points, excluding any point at the origin, which costs no energy.
 - (a) True
 - (b) False
7. In MATLAB, `(rand < p)` is a bit equal to 1 with probability p , for $0 \leq p \leq 1$.
 - (a) True
 - (b) False
8. The differential entropy of a continuous random variable is nonnegative, like the entropy of a discrete one.
 - (a) True
 - (b) False
9. For the binary erasure channel with erasure probability ε , the mutual information with equiprobable inputs is $1 - \varepsilon$ bits per channel use.
 - (a) True
 - (b) False
10. The capacity of the real AWGN channel with average symbol energy E_s and noise variance σ^2 is $\log_2(1 + \frac{E_s}{\sigma^2})$ bits per channel use.
 - (a) True
 - (b) False
11. Where two likelihoods tie, the maximum likelihood detector decides by the prior, whereas the maximum a posteriori detector may decide arbitrarily.
 - (a) True
 - (b) False
12. The shortest reversible mapping of groups of k bits onto sequences of symbols of an M -point constellation carries exactly $\log_2 M$ bits per symbol.
 - (a) True
 - (b) False