

Name: _____

Problem	Points	Score
1(a)	15	
1(b)	10	
2(a)	15	
2(b)	10	
3(a)	15	
3(b)	10	
4	25	
Total	100	

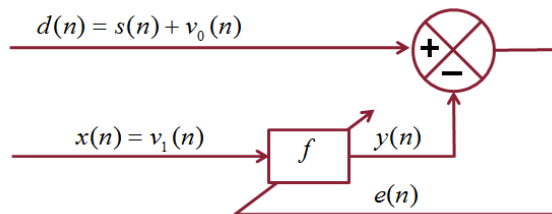
Notes:

- (1) The exam is closed books and notes except for two double-sided sheets of notes.
- (2) Please indicate clearly your answer to the problem.
- (3) The details of your solutions are more important than the answers. Please explain your solutions clearly and include as many details as possible.

1. The standard adaptive noise canceller is shown to the right.

(a) Derive an expression for the optimal filter such that the energy of the noise is minimized.

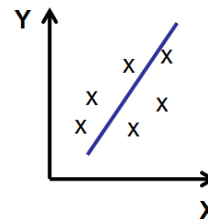
(b) Suppose instead of this approach you simply computed a linear prediction model on the noisy input signal. Compare and contrast the model you would obtain to the model in (a).



2. Recall our expression for a simple linear regression model that formed the basis for maximum likelihood linear regression.

$$Y = \beta_0 + \beta_1 X$$

$$\beta_0 = \bar{Y} - \beta_1 \bar{X} \quad \beta_1 = \frac{\bar{X}\bar{Y} - (\bar{X})(\bar{Y})}{\bar{X}^2 - (\bar{X})^2}$$



(a) Derive the optimal value of the slope.

(b) Describe, in qualitative terms, how you would apply this to the problem of adaptation of the model parameters of a Gaussian mixture model. Discuss the pros and cons of this approach.

3. In this class we introduced the concept of maximum a posteriori (MAP) adaptation.

(a) Derive the MAP estimate of the mean of a single Gaussian distribution assuming the variance is fixed.

(b) Discuss (but do not derive) properties of this estimate, such as bias. Comment on the implications of the resulting equations in terms of application of this technique to a Gaussian model of common time series such as a speech or image signal.

4. In this course, we discussed a range of adaptation topics beginning with the least mean square error (LMS) approaches and ending with approaches based on discriminative training. Describe the course in terms of a tree where the root node is labeled ECE 8423, and all other topics are arranged in a hierarchy representing their relationships with each other. Then provide a glossary: describe the essence of each term represented at each node in a small number of sentences.

Do not feel constrained by the way I presented the course – there is not only one correct answer. Your answers will be judged on their own merits based upon the amount of insight you demonstrate and the completeness of your hierarchy.