

Indian Institute of Science

E9: 252 Mathematical Methods and Techniques in Signal Processing

Instructor: Shayan Srinivasa Garani

Mid Term Exam, Spring 2021

Name and SR.No:

Instructions:

- This is an open book, open notes exam
- There are four main questions. None of them have negative marking.
- Attempt all of them with careful reasoning and justification for partial credit.
- There is absolutely no collaboration with any human or a bot.
- This is a take home exam. Assigned on May 22nd, 2021, 11:59 pm. Turn in by May 24, 2021 11:59 pm.
- Do not panic, do not cheat, good luck!

Question No.	Points scored
1	
2	
3	
4	
Total points	

PROBLEM 1: Solve problem 5.4 from P. P. Vaidyanathan's book.

(10 pts.)

PROBLEM 2: This problem has 2 parts:

- (1) Verify the validity of equation (5.9.9) in P. P. Vaidyanathan's book. (5 pts.)
- (2) Solve problems 5.22, 5.28 and 5.29 from P. P. Vaidyanathan's book. (30 pts.)

PROBLEM 3: Solve problems 2.13 and 2.14 from P. P. Vaidyanathan's book.

(20 pts.)

PROBLEM 4: This problem has three parts:

- (1) Solve problems 3.5 and C.1 from P. P. Vaidyanathan's book. (20 pts.)
- (2) Is it possible that the autocorrelation matrix of a certain random process is not symmetric? If so, justify the nature of the random process through an example. (5 pts.)
- (3) Four equally likely signals are located at coordinates (0,0), (0,1), (1,0) and (1,1) in \mathbb{R}^2 signal space. Suppose Gaussian noise with variance σ^2 acts independently on the signal coordinates, evaluate the probability of error for the optimal detector. Sketch your decision regions carefully. (10 pts.)