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.)