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reviewer4@nptel.iitm.ac.in ▼

Courses » Mathematical Methods and Techniques in Signal Processing

Announcements **Course** Ask a Question Progress FAQ

Week 12 - Fourier Series - II and KL Transform

Register for Certification exam

Course outline

How to access the portal

Week 0 - Background and Prerequisites

Week 1 - Introduction to Signal Processing, State Space Representation and Vector Spaces - I

Week 2 - Vector Spaces - II

Week 3 - Vector Spaces - III and Signal Geometry

Week 4 - Probability and Random Processes

Week 5 - Sampling Theorem and Multirate Systems - I

Assignment 12

The due date for submitting this assignment has passed.

As per our records you have not submitted this assignment. **Due on 2019-04-24, 23:59 IST.**

Instructions:

1. Attempt all questions.
2. Submission deadline: 24th April 2019 23:59 IST
3. Solutions to be posted: 25th April 2019
4. Older browsers might show unnecessary vertical bars at the end of math equations.

1) Consider the vector $v = [1 \ 4 \ 8]^T$. Let A be the KL transform obtained from a set of vectors containing v . What is the norm of the vector $u = Av$ obtained after performing KL Transform on the vector v ? Provide your answer upto two decimal places.

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 9.00

1.5 points

2) Which of the following functions belong to $L^2[0, 1]$?

2 points

$$f_1(x) = \begin{cases} k & 0 \leq x \leq 1 \\ 0 & \text{else} \end{cases} \text{ where } 100 - |k| > 0$$

$$f_2(x) = \frac{1}{x^m} \text{ where } m > 0 \text{ and } m \in \mathbb{Z}$$

$$f_3(x) = \sin mx \text{ where } m \geq 0 \text{ and } m \in \mathbb{Z}$$

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Week 8 - Multirate Systems - IV

Week 9 - Wavelets - I

Week 10 - Wavelets - II and Continuity of Functions

Week 11 - Fourier Series - I

Week 12 - Fourier Series - II and KL Transform

- Convergence in norm of Fourier series
- Convergence of Fourier series for all square integrable periodic functions
- Problem on limits of integration of periodic functions
- Matrix Calculus
- KL transform
- Applications of KL transform
- Demo on KL Transform
- Quiz : Assignment 12
- Assignment 12 - Solutions

Interaction Session

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$$f_1(x) = \begin{cases} k & 0 \leq x \leq 1 \\ 0 & \text{else} \end{cases} \text{ where } 100 - |k| > 0$$

$$f_3(x) = \sin mx \text{ where } m \geq 0 \text{ and } m \in \mathbb{Z}$$

$$f_4(x) = x^m \text{ where } m > 0, m \text{ is finite and } m \in \mathbb{Z}$$

3) (True/False): Consider the function $f(x) = \sin 45x \cos 45x$. Let $f_N(x)$ be the orthogonal projection of $f(x)$ onto the space V_N , as defined in Lecture 71. As $f(x)$ is a scaled version of a basis function in the Fourier basis, there exists $L \in \mathbb{Z}$ such that $f_N(x) = f(x)$ for $N = L$ and $f_N(x) = 0$ for $N \neq L$. 2 points

- True
- False

No, the answer is incorrect.

Score: 0

Accepted Answers:

False

4) Consider the following optimization problem: 2 points
 minimize $x^T x$
 subject to $\{a_i^T x = b_i\}$ for $i \in \{1, 2, \dots, n\}$ where $a_i, x \in \mathbb{R}^m, b_i \in \mathbb{R}$,

Consider $\{\nu_i\}$'s to be the Lagrange multipliers. Then, the Lagrangian is obtained as $L(x, \nu_1, \dots, \nu_n) = x^T x + \sum_{i=1}^n \nu_i (a_i^T x - b_i)$.

Using this Lagrangian, we reduce the problem to the following problem

$$\text{minimize}_x x^T x + \sum_{i=1}^n \nu_i (a_i^T x - b_i)$$

As this is an unconstrained problem, we solve it by equating the derivative of the Lagrangian with respect to x to 0. Find the value of x which gives the optimal solution.

- 0
- $\frac{\sum_{i=1}^n \nu_i a_i^T}{2}$
- $\frac{\sum_{i=1}^n \nu_i b_i - \nu_i a_i^T}{2}$
- $-\frac{\sum_{i=1}^n \nu_i a_i}{2}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$-\frac{\sum_{i=1}^n \nu_i a_i}{2}$$

5) (True/False): The following points are uncorrelated : $[1 \ 1]^T, [2 \ -2]^T, [1 \ 4]^T$ and $[0 \ 1]^T$. 2 points

- True
- False

No, the answer is incorrect.

Score: 0

Accepted Answers:

False

6) Which of the following vectors are the dominant eigenvectors of the covariance 2 points

matrix $C = \begin{bmatrix} 4 & 1 \\ 1 & 4 \end{bmatrix}$?

$$\begin{bmatrix} 3 & -3 \end{bmatrix}^T$$

$$\begin{bmatrix} -1 & -1 \end{bmatrix}^T$$

$$\begin{bmatrix} 4 & -1 \end{bmatrix}^T$$

$$\begin{bmatrix} 1 & 1 \end{bmatrix}^T$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{bmatrix} -1 & -1 \end{bmatrix}^T$$

$$\begin{bmatrix} 1 & 1 \end{bmatrix}^T$$

7) Consider the covariance matrix C given below obtained from 5 random vectors of length 3.

$$C = \begin{bmatrix} 3 & -1 & 2 \\ -1 & 6 & 2 \\ 2 & 2 & 3 \end{bmatrix}$$

We intend to reduce the dimension of the vectors while retaining 95% of the energy. To what dimension can we reduce the vectors?

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 2

2 points

8) Consider the vectors $\begin{bmatrix} 0 & 2 \end{bmatrix}^T$, $\begin{bmatrix} 0 & -6 \end{bmatrix}^T$, $\begin{bmatrix} 6 & 0 \end{bmatrix}^T$, and $\begin{bmatrix} -2 & 0 \end{bmatrix}^T$. With reference to lecture 76, which of the following represents the covariance matrix of these vectors? **1.5 points**

$$\begin{bmatrix} 36 & 4 \\ 4 & 36 \end{bmatrix}$$

$$\begin{bmatrix} 12 & 1.33 \\ 1.33 & 12 \end{bmatrix}$$

$$\begin{bmatrix} 9 & 1 \\ 1 & 9 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{bmatrix} 36 & 4 \\ 4 & 36 \end{bmatrix}$$

9) Using the KL transform obtained using the vectors in Question 8, let $[a \ b]^T$ be the KL transform of $[3 \ -5]^T$. Let the lower energy correspond to the second coordinate. Consider the eigenvectors in obtaining the KL transform to be normalized. What is $|a||b|$?

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 8



2.5 points

10) (True/False): As $f_n(x) = \begin{cases} 1 & \frac{3}{5} - \frac{1}{n^2} \leq x \leq \frac{3}{5} + \frac{1}{n^2} \\ 0 & \text{else} \end{cases}$ converges

to 0 in $L^2[0, 1]$, it also converges uniformly to 0 in $[0, 1]$.

- True
 False

No, the answer is incorrect.

Score: 0

Accepted Answers:

False



2.5 points

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