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NPTEL

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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

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.

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1) Consider the vector $v = [1\ 4\ 8]^{\mathrm{T}}$. 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***

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

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

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

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

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

$f_4(x) = x^m$ where $m > 0$, m 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***

$$\text{minimize } x^T x$$
$$\text{subject to } \{a_i^T x = b_i\} \text{ for } i \in \{1, 2, \ldots, n\} \text{ where } a_i, x \in \mathbb{R}^m, b_i \in \mathbb{R},$$

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

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

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

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 : $[1 \quad 1]^T, [2 \quad -2]^T, [1 \quad 4]^T$ and $[0 \quad 1]^T$. ***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 $[a \quad b]^{\mathrm{T}}$ be the KL transform of $[3 \quad -5]^{\mathrm{T}}$. 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

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

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