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Courses » Mathematical Methods and Techniques in Signal Processing

Announcements **Course** Ask a Question Progress FAQ

# Week 2 - Vector Spaces - II

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**

Linear independence and spanning set

Unique representation theorem

Basis and cardinality of basis

Norms and inner product spaces

## Assignment 02

The due date for submitting this assignment has passed.

As per our records you have not submitted this assignment. **Due on 2019-02-13, 23:59 IST.**

### Instructions:

1. Attempt all questions.
2. Submission deadline: 13th February 2019 23:55 IST
3. Solutions to be posted: 14th February 2019
4. Older browsers might show unnecessary vertical bars at the end of math equations

1) Consider the vectors  $u = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}$  and  $v = \begin{bmatrix} 1 \\ -2 \\ 3 \end{bmatrix}$  in  $\mathbb{R}^3$ . Let us consider the inner product,

$$\langle u, v \rangle = u_1v_1 + b(u_2v_2) + u_3v_3$$

where  $b \in \mathbb{R}$ .  $u_i$  and  $v_i$  represent the  $i^{\text{th}}$  element of  $u$  and  $v$  respectively. For what value of  $b$  are the vectors  $u$  and  $v$  orthogonal?

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 2

1 point

1.5 points

2) Let  $\mathcal{S} = \{a, b, c, d\}$  be a subset of  $\mathbb{R}^5$  where

$$a = \begin{bmatrix} 1 \\ 0 \\ 1 \\ 0 \\ 0 \end{bmatrix}, b = \begin{bmatrix} 0 \\ 1 \\ 3 \\ 1 \\ 0 \end{bmatrix}, c = \begin{bmatrix} 1 \\ 1 \\ 4 \\ 1 \\ 0 \end{bmatrix}, d = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

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- Problem on sum of subspaces
- Quiz : Assignment 02
- Assignment 2 - Solutions

**Week 3 - Vector Spaces - III and Signal Geometry**

**Week 4 - Probability and Random Processes**

**Week 5 - Sampling Theorem and Multirate Systems - I**

**Week 6 - Multirate Systems - II**

**Week 7 - Multirate Systems - III**

**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**

**Interaction Session**

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 5

**No, the answer is incorrect.**  
**Score: 0**

**Accepted Answers:**  
 3

3) Consider the vectors  $u = [1 \ -2 \ 3]^T$  and  $v = [-2 \ 4 \ -6]^T$  in  $\mathbb{R}^3$ . Using which of **1.5 points** the following sets can these vectors be represented uniquely?

$A = \{[1 \ -2 \ 3]^T\}$

$B = \{[1 \ 0 \ 0]^T, [0 \ 0 \ 1]^T\}$

$C = \{[1 \ -2 \ 3]^T, [-2 \ 4 \ -6]^T\}$

None of the above

**No, the answer is incorrect.**  
**Score: 0**

**Accepted Answers:**  
 $A = \{[1 \ -2 \ 3]^T\}$

4) The  $L_2$ -norm of  $g(x) = 5x^2 - 3x - 1$  over  $[0, 1]$  is **1.5 points**

$\sqrt{\frac{5}{6}}$

$\sqrt{\frac{25}{6}}$

$\sqrt{\frac{7}{6}}$

$\frac{5}{\sqrt{6}}$

**No, the answer is incorrect.**  
**Score: 0**

**Accepted Answers:**  
 $\sqrt{\frac{7}{6}}$

5) Consider vectors  $x, y, z \in \mathbb{R}^2$  such that  $y = x - z$  and  $\|x\| = \|z\|$ . Let  $\theta_1$  be the **2 points** angle between  $x$  and  $y$ . Let  $\theta_2$  be the angle between  $z$  and  $y$ . Which of the following relations does  $\theta_1$  and  $\theta_2$  always satisfy?

$|\cos\theta_1| = |\cos\theta_2|$

$|\cos\theta_1|^2 + |\cos\theta_2|^2 = 1$

$|\cos\theta_1|^2 + |\sin\theta_2|^2 = 1$

No relation exists.

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$|\cos\theta_1| = |\cos\theta_2|$$

$$|\cos\theta_1|^2 + |\sin\theta_2|^2 = 1$$

6) If  $u$  and  $v$  are orthogonal vectors in the inner product space  $\mathcal{V}$ , such that  $\|u\| = 6$  and  $\|u + v\| = 10$ , then what is the value of  $\|v\|$  and  $\|u - v\|$ ?

2 points

- 4, 2
- 8, 10
- 6, 12
- 8,  $\sqrt{28}$



No, the answer is incorrect.

Score: 0

Accepted Answers:

8, 10

7) Find the dimension of the plane  $2x - 3y = 0$  in  $\mathbb{R}^3$ .

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 2

2 points

8) Let  $A$  and  $B$  be subspaces of the vector space of  $2 \times 2$  matrices defined over integers. Then, subspace  $C$  is said to be the direct sum

of  $A$  and  $B$  if  $C = A + B$  and  $A \cap B = \left\{ \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \right\}$ . The basis of the subspaces are given by  $\mathcal{B}_A = \left\{ \begin{bmatrix} m-12 & 9 \\ 0 & m \end{bmatrix}, \begin{bmatrix} 0 & m \\ 1 & 2 \end{bmatrix} \right\}$  and  $\mathcal{B}_B = \left\{ \begin{bmatrix} m & 0 \\ 1 & 1 \end{bmatrix} \right\}$ . For what value of  $m$  is  $C = A + B$  not a direct sum?

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Numeric) 3

2.5 points

9) Let  $S = \{u_1, u_2, u_3\}$  be a linearly independent set in  $\mathbb{R}^n$ , which of the following are true? **3 points**

The set  $\{u_1 + u_2, u_2 + u_3, u_3 + u_1\}$  is linearly independent.

The set  $\{u_1 - u_2, u_2 - u_3, u_3 - u_1\}$  is linearly independent.

The set  $\{u_1, u_1 + u_2, u_1 + u_2 + u_3\}$  is linearly independent.

The set  $\{u_1 - 2u_2, u_2 - 2u_3, u_3 - 2u_1\}$  is linearly independent.

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

*The set  $\{u_1 + u_2, u_2 + u_3, u_3 + u_1\}$  is linearly independent.*

*The set  $\{u_1, u_1 + u_2, u_1 + u_2 + u_3\}$  is linearly independent.*

*The set  $\{u_1 - 2u_2, u_2 - 2u_3, u_3 - 2u_1\}$  is linearly independent.*

10) What is the maximum value of  $x - 2y + z$  subject to the constraint  $x^2 + 2y^2 + z^2 = 1$ ?

**3 points**

0

1

2

3

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

2

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