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Courses » Applied Optimization for Wireless, Machine Learning, Big-Data

Announcements **Course** Ask a Question Progress Mentor FAQ

# Unit 4 - Week 2: Introduction to Convex Optimization – Convex sets, Hyperplanes/ Half-spaces etc. Application: Power constraints in Wireless Systems

## Course outline

How to access the portal

Week 1 : Introduction to properties of Vectors, Norms, Positive Semi-Definite matrices and Gaussian Random Vectors

DOWNLOAD VIDEOS

Week 2: Introduction to Convex Optimization – Convex sets, Hyperplanes/ Half-spaces etc. Application: Power constraints in Wireless Systems

- Lec 07- Gram Schmidt Orthogonalization Procedure
- Lec 08- Null

## Assignment-2

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment. **Due on 2018-08-15, 23:59 IST.**

1) Triangle inequality for vectors is 1 point

- $\|\bar{\mathbf{u}} + \bar{\mathbf{v}}\| \leq (\|\bar{\mathbf{u}}\| + \|\bar{\mathbf{v}}\|)^2$
- $\|\bar{\mathbf{u}} + \bar{\mathbf{v}}\| \leq \|\bar{\mathbf{u}}\|^2 \|\bar{\mathbf{v}}\|^2$
- $\|\bar{\mathbf{u}} + \bar{\mathbf{v}}\| \leq \|\bar{\mathbf{u}}\| + \|\bar{\mathbf{v}}\|$
- $\|\bar{\mathbf{u}}^T \bar{\mathbf{v}}\| \leq \|\bar{\mathbf{u}}\|^2 \|\bar{\mathbf{v}}\|^2$

No, the answer is incorrect. Score: 0

Accepted Answers:  $\|\bar{\mathbf{u}} + \bar{\mathbf{v}}\| \leq \|\bar{\mathbf{u}}\| + \|\bar{\mathbf{v}}\|$

2) Cauchy-Schwarz inequality for two real vectors is 1 point

- $\bar{\mathbf{u}}^T \bar{\mathbf{v}} \leq \|\bar{\mathbf{u}}\|^2 \|\bar{\mathbf{v}}\|^2$
- $|\bar{\mathbf{u}}^T \bar{\mathbf{v}}| \leq \|\bar{\mathbf{u}}\| \|\bar{\mathbf{v}}\|$
- $(\bar{\mathbf{u}}^T \bar{\mathbf{v}})^2 \geq \|\bar{\mathbf{u}}\| \|\bar{\mathbf{v}}\|$

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Properties

- Lec 10- Matrix Inversion Lemma (Woodbury identity)
- Lec 11- Introduction to Convex Sets and Properties
- Lec 12- Affine Set Examples and Application
- Quiz : Assignment-2
- Assignment-2 Solution
- WEEK-2 FEEDBACK

**Week 3 :**  
**Convex/Concave Functions, Examples, Conditions for Convexity. Application: Beamforming in Wireless Systems, Multi-User Wireless, Cognitive Radio Systems**

**Week 4 : Convex Optimization problems, Linear Program, Application: Power allocation in Multi-cell cooperative OFDM**

**Week 5:**  
**Jensen's Inequality, Operations that preserve Convexity, Examples, Beamforming in Multi-antenna Wireless Communication**

**Week-6: Maximal Ratio Combiner (MRC), Multi-antenna Beamforming with Interfering User, Zero-Forcing**

3) The cosine of the angle between two real vectors is

1 point

$$\frac{\bar{\mathbf{u}}^T \bar{\mathbf{v}}}{\|\bar{\mathbf{u}}\| \|\bar{\mathbf{v}}\|}$$

$$\frac{(\bar{\mathbf{u}}^T \bar{\mathbf{v}})^2}{\|\bar{\mathbf{u}}\|^2 \|\bar{\mathbf{v}}\|^2}$$

$$\frac{(\bar{\mathbf{u}}^T \bar{\mathbf{v}})^2}{\|\bar{\mathbf{u}}\| \|\bar{\mathbf{v}}\|}$$

$$\frac{\bar{\mathbf{u}}^T \bar{\mathbf{v}}}{\|\bar{\mathbf{u}}\|^2 \|\bar{\mathbf{v}}\|^2}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{\bar{\mathbf{u}}^T \bar{\mathbf{v}}}{\|\bar{\mathbf{u}}\| \|\bar{\mathbf{v}}\|}$$

4) The inner product  $\langle \mathbf{A}, \mathbf{B} \rangle$  of two real matrices  $\mathbf{A}, \mathbf{B}$  can be defined as

1 point

$$\mathbf{AB}$$

$$\mathbf{A}^T \mathbf{B}$$

$$\text{Tr}(\mathbf{A}^T \mathbf{B})$$

$$\|\mathbf{AB}\|$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\text{Tr}(\mathbf{A}^T \mathbf{B})$$

5) The reduced row echelon form of the matrix  $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$  is

1 point

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & -2 & -2 \\ 0 & 0 & 3 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & 2 & -2 \\ 0 & 0 & -3 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & -3 & -5 \\ 0 & 0 & 4 \end{bmatrix}$$

(ZF) beamforming, Robust beamformer Design

Week-7: Optimization for signal estimation, LS, WLS, Regularization. Application: Wireless channel estimation, Image Reconstruction-Deblurring, Representations of Convex Optimization problem

Week 8 : Application: Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines

Week 9- Application: Compressive Sensing, Sparse Signal Processing, OMP (Orthogonal Matching Pursuit), LASSO (Least Absolute Shrinkage and Selection Operator) for signal estimation, SVM

Week 10- Application: Compressive Sensing, Sparse Signal Processing, OMP (Orthogonal Matching Pursuit), LASSO (Least Absolute Shrinkage and Selection Operator) for signal estimation

Week 11 : Application:

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & -3 & -6 \\ 0 & 0 & 0 \end{bmatrix}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{bmatrix} 1 & 2 & 3 \\ 0 & -3 & -6 \\ 0 & 0 & 0 \end{bmatrix}$$

6) The rank of the matrix  $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$  is

1 point

- 0
- 1
- 2
- 3

No, the answer is incorrect.

Score: 0

Accepted Answers:

2

7) The null space of a matrix  $\mathbf{A}$  is

1 point

- Matrix of size  $\mathbf{A}$  with all entries 0
- Vector with size equal to number of columns of  $\mathbf{A}$  with all entries 0
- Any matrix  $\mathbf{B}$  such that  $\text{Tr}(\mathbf{A}^T \mathbf{B}) = 0$
- Subspace of all vectors  $\bar{\mathbf{x}}$  such that  $\mathbf{A}\bar{\mathbf{x}} = 0$

No, the answer is incorrect.

Score: 0

Accepted Answers:

Subspace of all vectors  $\bar{\mathbf{x}}$  such that  $\mathbf{A}\bar{\mathbf{x}} = 0$

8) Consider the vectors  $\begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}$ ,  $\begin{bmatrix} 1 \\ 1 \\ 2 \end{bmatrix}$ . The set of orthonormal vectors derived by Gram-Schmidt Orthonormalization is

1 point

- $\frac{1}{\sqrt{6}} \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}$ ,  $\frac{1}{\sqrt{66}} \begin{bmatrix} 1 \\ -4 \\ 7 \end{bmatrix}$
- $\frac{1}{\sqrt{6}} \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}$ ,  $\frac{1}{\sqrt{49}} \begin{bmatrix} -2 \\ 6 \\ 3 \end{bmatrix}$

Radar for target detection, Array Processing, MUSIC, MIMO-Radar Schemes for Enhanced Target Detection

Week 12:  
Application: Convex optimization for Big Data Analytics, Recommender systems, User Rating Prediction and Optimization for Finance

Transcripts

$$\frac{1}{6} \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}, \frac{1}{35} \begin{bmatrix} -5 \\ 3 \\ -1 \end{bmatrix}$$



$$\frac{1}{\sqrt{6}} \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}, \frac{1}{\sqrt{26}} \begin{bmatrix} 1 \\ 4 \\ 3 \end{bmatrix}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{1}{\sqrt{6}} \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}, \frac{1}{\sqrt{66}} \begin{bmatrix} 1 \\ -4 \\ 7 \end{bmatrix}$$

9) The nullity or dimension of the null space of  $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$  is

1 point



0



1



2



3

No, the answer is incorrect.

Score: 0

Accepted Answers:

1

10) Consider the matrix  $\mathbf{A} = [\bar{\mathbf{u}}_1 \ \bar{\mathbf{u}}_2 \ \cdots \ \bar{\mathbf{u}}_n]$  of size  $m \times n$ , with  $m \geq n$  and the vectors  $\bar{\mathbf{u}}_i$  are real and pairwise orthogonal. Which of the following properties are always true

1 point

- i The matrix  $\mathbf{A}$  is invertible
- ii  $\mathbf{A}$  has full rank
- iii  $\mathbf{A}^T \mathbf{A} = \mathbf{I}$ , where  $\mathbf{I}$  denotes the identity matrix
- iv  $\mathbf{A}^T \mathbf{A}$  is diagonal



i, iii



ii, iv



i, iv



ii, iii

No, the answer is incorrect.

Score: 0

Accepted Answers:

ii, iv

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