**Code and Name:**

**MAT5930 Statistical Manifolds**

**Unit:**

Institute of Science, Department of Mathematics

**Details:**

* **Term:** 2023-2024 Spring
* **Status:** Elective
* **Class Level:** 1
* **Credit Hours:** 3-0-0-3
* **ECTS:** 6
* **Language:** Turkish

**Course Instructors:**

* **Course Coordinator:** ...
* **Assistant Instructor:** ...
	+ **Phone:** ...
	+ **Email:** ...@firat.edu.tr
	+ **Social Accounts:** ...

**Weekly Schedule**

| **Monday** | **Tuesday** | **Wednesday** | **Thursday** | **Friday** | **Saturday** |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

**Teaching Method:**
Each weekly hour will include at least 45 minutes of face-to-face teaching.

**Location:**

* **In-person (YY):** Classroom (To be announced)
* **Remote (UE):** -

**Objective:**

To study the concept of statistical manifolds, learn about flat structures and the Fisher metric, establish connections between probability distributions and manifolds, examine various types of divergence and their properties, and explore concepts of α-geometry in nnn-spheres and nnn-dimensional Euclidean spaces.

**Materials:**

1. S. Amari, *Information Geometry and Its Applications*, Springer, 2016
2. S. Amari, *Differential-Geometrical Methods in Statistics*, Springer, 1985
3. B. O'Neil, *Elementary Differential Geometry*, Academic Press, 1983
4. M.K. Murray, J.W. Rice, *Differential Geometry and Statistics*, Chapman & Hall/CRC, 1993

**Student Responsibilities:**

Students are required to attend at least 70% of the classes.

**Weekly Lesson Plan:**

| **Week** | **Topic** | **Methodology** |
| --- | --- | --- |
| 1 | Introduction to the course and key concepts | Face-to-Face |
| 2 | **Manifolds and Flat Structures**: Definitions and examples of divergence | Face-to-Face |
| 3 | **Convex Functions**: Convex structures, Bergman divergence, Legendre transformation | Face-to-Face |
| 4 | Dual flat Riemannian structures derived from convex functions | Face-to-Face |
| 5 | Generalized Pythagorean and Projection Theorems | Face-to-Face |
| 6 | **Exponential Families**: Probability distributions, Gaussian and discrete distributions | Face-to-Face |
| 7 | Mixture families and probability distributions on infinite-dimensional manifolds | Face-to-Face |
| 8 | Applications of the Pythagorean Theorem, invariance criteria, and f-divergence | Face-to-Face |
| 9 | **Midterm Exam** | Face-to-Face |
| 10 | Properties of f-divergence and chi-square divergence | Face-to-Face |
| 11 | Fisher metric as a unique invariant metric | Face-to-Face |
| 12 | f-divergence in positively measured manifolds | Face-to-Face |
| 13 | α-geometry in RmR^mRm: α-geodesics and the α-Pythagorean theorem | Face-to-Face |
| 14 | α-geometry in nnn-spheres: α-geodesics and the α-Pythagorean theorem | Face-to-Face |

**Assessment and Evaluation:**

| **Method** | **Quantity** | **Weight** |
| --- | --- | --- |
| **Midterm Exam** | 1 | 50% |
| **Quizzes** | None | - |
| **Assignments** | Pre- and post-midterm activities | - |
| **Projects** | None | - |
| **Final Exam** | 1 | 50% |

**Learning Outcomes:**

1. Understand statistical manifolds.
2. Learn probability distributions and flat structures.
3. Study the generalized Pythagorean and Projection Theorems.
4. Learn α-geometry concepts in nnn-spheres and nnn-dimensional Euclidean spaces.
5. Analyze concepts in statistical manifold theory using scientific methods.

**Special Notes:**

* **UE:** Remote Education
* **YY:** Face-to-Face Education