**Code and Name:**

**MAT5910 Hessian 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 Hessian manifolds, understand Hessian structures and metrics, examine curvature and curvature equations on Hessian manifolds, establish relationships between Hessian and Kähler structures, and develop foundational knowledge in affine differential geometry concepts.

**Materials:**

1. H. Shima, *Geometry of Hessian Structures*, World Scientific Press, 2007
2. K. Nomizu, T. Sasaki, *Affine Differential Geometry*, Cambridge University Press, 1994
3. B. O’Neil, *Elementary Differential Geometry*, Academic Press, 1983
4. H.H. Hacısalihoğlu, N. Ekmekci, *Tensor Geometry*, Ankara University, 2004
5. K. Yano, M. Kon, *Structures on Manifolds*, World Scientific Publishing, 1980

**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 | **Affine Spaces**: Definitions, connections, vector fields | Face-to-Face |
| 3 | **Hessian Structures**: Hessian metric, difference tensor, Codazzi equations | Face-to-Face |
| 4 | **Hessian and Kähler Structures**: Complex manifolds, Kähler metric | Face-to-Face |
| 5 | Properties of Hessian structures, dual Hessian structures | Face-to-Face |
| 6 | **Examples of Hessian Manifolds**: Applications | Face-to-Face |
| 7 | **Curvature Tensors**: Basic curvature tensors, Ricci scalar, sectional curvatures | Face-to-Face |
| 8 | Curvatures for Hessian structures: Hessian curvature tensor, Koszul forms | Face-to-Face |
| 9 | **Midterm Exam** | Face-to-Face |
| 10 | Relationships between Riemann, Kähler, and Hessian curvatures | Face-to-Face |
| 11 | Fundamentals of affine differential geometry | Face-to-Face |
| 12 | **Affine Differential Geometry**: Affine hypersurfaces | Face-to-Face |
| 13 | **Hessian Structures and Information Geometry**: Dual connections in probability distribution families | Face-to-Face |
| 14 | Statistical manifolds as examples of Hessian manifolds | 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 affine geometry.
2. Comprehend the concepts of Hessian manifolds and Hessian structures.
3. Define and compute the Hessian curvature tensor.
4. Understand Kähler manifold theory and relate it to Hessian manifolds.
5. Understand the relationship between Hessian manifold theory and statistical manifolds.

**Special Notes:**

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