CALCULUS OF VARIATIONS AND OPTIMAL CONTROL

1. Instructors Information

- **Instructor:** Cristopher Hermosilla
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2. Course Description

This course is an introduction to the Calculus of Variations and Optimal Control from a modern viewpoint that will emphasize the role of convexity. It is aimed at graduate and advanced undergraduate students interested in the theoretical foundations of any area of applied mathematics.

We will begin with a review of continuous optimization in Euclidean space; the role of convexity will be emphasized and basic tools of nonsmooth analysis will be introduced. The main topic of the course is dynamic optimization. The first half will cover the classical material of the calculus of variations, including topics such as the Euler-Lagrange equation, Weierstrass maximality condition, Erdmann corner conditions, and Jacobi conjugate points.

Plenty of examples will be covered. There is a natural transition into optimal control, which will be the focus of the rest of the course from a neo-classical point of view.

3. Schedule of the course

Date	Contents	Instructor
08/22 - 09/23	Convex analysis and Optimization	C. Hermosilla
09/26 - 10/28	Classical Calculus of Variation	P. Wolenski
10/31 - 12/02	Optimal control and Fully convex problems	C. Hermosilla

4. Graded Work

It will consist in 6 homework (2 for each of the topics described above). Homework will be published by each instructor when appropriate. Homework will be due 2 or 3 weeks after publication.

5. Bibliography

No formal text is required, however some books are given as reference.

References

[1] J.-P. Aubin and A. Cellina. *Differential inclusions: Set-valued maps and viability theory*, volume 264 of *Grundlehren der Mathematischen Wissenschaften*. Springer-Verlag New York, Inc., 1984.

[2] J. Borwein and J. Vanderwerff. *Convex functions: Constructions, characterizations and counterexamples*, volume 109 of *Encyclopedia of Mathematics and its Applications*. Cambridge University Press, 2010.

[3] H. Brézis H. *Functional analysis, Sobolev spaces and partial differential equations*. Springer; 2011.

[4] F. Clarke. *Functional analysis, calculus of variations and optimal control*, volume 264 of *Graduate Text in Mathematics*. Springer, 2013.

[5] F. Clarke, Y. Ledyaev, R. Stern, and P. Wolenski. *Nonsmooth Analysis and Control Theory*, volume 178 of *Graduate Text in Mathematics*. Springer, 1998.

[6] R. Rockafellar. *Convex analysis*, volume 28 of *Princeton Mathematical Series*. Princeton University Press, 1970.

[7] R. Rockafellar. *Conjugate duality and Optimization*, volume 16 of *CBMS-NSF Regional Conference Series in Applied Mathematics*. SIAM publications, 1974.

[8] R. Vinter. *Optimal control*. Springer Science & Business Media, 2010.