PMATH 965: Einstein Metrics
WINTER 2028

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Course description. This course is survey of various results on the Riemannian geometry of Einstein metrics. The classical text of Besse (Einstein Manifolds) is our primary source. We will attempt to cover about half of the book, omitting the deeper results on Ricci curvature as a partial differential equation, so as to minimize the necessary prerequisites. More precisely, the plan is to consider the following topics (tentative and subject to change):

- Chapters 1 & 2: review of basic facts from Riemannian geometry and Kähler geometry
- Chapter 4: the Einstein-Hilbert functional; first and second variations
- Chapters 7 & 8: homogeneous Riemannian manifolds and homogeneous Kähler manifolds
- Chapter 9: Riemannian submersions; applications to Einstein metrics, the canonical variation
- Chapter 12: the moduli space of Einstein metrics; infinitesimal Einstein deformations; formal integrability
- Chapter 13: four dimensions; self-duality
- Chapter 14: quaternionic-Kähler geometry

Textbook: I will be primarily following *Einstein Manifolds* by Arthur L. Besse (Springer, 1987).

Prerequisites: Students should absolutely be familiar with smooth manifold theory at the level of PMATH 665, including tensors, differential forms, Stokes's Theorem, Lie derivatives, and flows of vector fields. Previous exposure to Riemannian geometry and to Lie groups is helpful but not essential.

Marking scheme:

- There will be five assignments.
- At the end of the term, each student will give a 40 minute oral presentation on a topic related to the course material.
- Class participation and attendance will count as part of your grade. This portion is entirely subjective.

You are strongly encouraged to work together with your classmates on the assignment problems, but you must write up and turn in your own solutions to the problems. It is okay to use AI to help you learn, but it is *not okay* to use AI to do your homework for you. I will definitely be able to tell. Don't do it. I report such cases as Academic Integrity violations.

Your course mark will be determined by the following scheme:

- Assignments: 60% (five assignments at 12.5% each)
- Oral presentation: 30%
- Class participation and attendance: 10%
