Department of Earth Sciences
Indian Institute of Technology Kanpur

Proposal for a new course

1. Course No: ES4XX
2. Course title: Glacier Processes
3. Department: Earth Sciences
4. Proposing Instructor: Dr. Thupstan Angchuk
5. Units: 3-0-0-0 (9 credits)
6. Offered For: Undergraduate students.
7. Course Type: Departmental Elective (UG)
8. Prerequisite: N.A.
9. Other Interested Faculty: Dr. Tajdarul H. Syed

Course Description

Glaciers are natural freshwater resources and are key indicators of climate change. Glacial landforms are the repositories of Earth's system processes and serve as records of past landscape changes. Glaciers are increasingly losing their mass, both on a global and local scale, impacting ecosystems, humans and climate. The Hindu Kush Himalayan (HKH) regions are the largest freshwater reserves outside the polar regions and are the sources of major river systems in Asia. HKH glaciers play a crucial role in the socio-economic and livelihood of the downstream regions. Therefore, it is crucial to comprehend the behaviour and dynamics of glaciers and the threat posed by global warming. This course covers all essential aspects of mountain snow and glaciers, from their formation, movement, meltwater generation, and landscape formation. It explains the different components of glaciers and their physical processes. It also highlights its importance as a water reservoir. Further, it examines the glaciers as efficient, powerful forces that have shaped a large part of the present-day relief of the Earth, one of the traditional areas of study in geology and geomorphology.

Course Contents	Suggested number of lectures
Fundamentals of snow and ice, physical, thermal and mechanical properties of snow and ice, transformation of snow to firn and then ice, variations in density with depth, zones in a glacier, type and classification of glaciers, distribution of the glaciers	8
Mass balance, accumulation and ablation processes, equilibrium line altitude and accumulation area ratio, specific and cumulative mass balance, mass balance gradient, Himalayan glacier mass balance, role of debris in glacier mass balance, glacier response time, glacier mass balance measurement methods	8
Glacier movement, stress and strain, deformation (plastic flow) and sliding (basal flow), glacier velocity and surging, velocity estimation methods	6
Snow and glacier hydrology, surface, englacial and subglacial melting, Himalayan glaciers as water resources, snow and glacier melt measurement techniques	6
Glacier geomorphology, erosional processes and features, glacier as a transportation agent, glacial deposition and landforms, glacier moraines, direct and indirect glacial landforms, glacial geomorphological mapping	8
Glacial period, role of Himalayan glacier	4
Total number of lectures	40

Recommended Books:

- Hubbard, B. D., & Evans, D. J. A. (2010). Glaciers and Glaciation (2nd ed.). Hodder Arnold Publication. Routledge.
- K.M. Cuffey and W.S.B. Paterson. (2010). The physics of glaciers. Fourth edition. Amsterdam, etc., Academic Press.
- Hagg, W. (2022). Glaciology and Glacial Geomorphology. Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 1st ed.
- Cogley, J.G., R. Hock, L.A. Rasmussen, A.A. Arendt, A. Bauder, R.J. Braithwaite, P. Jansson, G. Kaser, M. Möller, L. Nicholson and M. Zemp, 2011, Glossary of Glacier Mass Balance and Related Terms, IHP-VII Technical Documents in Hydrology No. 86, IACS Contribution No. 2, UNESCO-IHP, Paris.

Journals:

The Cryosphere
Journal of glaciology
Annals of Glaciology

Web:

World Glacier Monitoring Service (WGMS)
Intergovernmental Panel on Climate Change (IPCC)
National Snow and Ice Data Center (NSIDC)

Dated: 26th February 2025 Proposer: Dr. Thupstan Angchuk

Dated: DUGC/DPGC Convener, ES

The course is approved/ not approved

Chairman, SUGC/SPGC

Dated:_____