# ME – MTech(Res) Thesis Colloquium

## Direct Numerical Simulation of Square Vortex Flows

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**July 24, 2023 at 10AM**
**Venue – Conference Room, ME@IISc**

**ABSTRACT**
Atmospheric and oceanic flows are often modeled as two-dimensional due to their large planar extents (~ 1000 km) and small vertical extent (~ 10 km). Most phenomena in these systems are governed by the theory of two-dimensional turbulence. Rather than truncating the third dimension, its effect is modeled using additional friction term in the 2D Navier-Stokes equations. These equations are said to be applied to a class of flows called quasi-two-dimensional (Q2D) flows, which are essentially three-dimensional but almost planar flows. The approximation of Q2D-ness is widely applied for shallow fluid layers in laboratory experiments.

We study Q2D flows generated by electromagnetically driving a shallow electrolyte layer. The specific form of forcing mimics that of a chessboard, where the laminar flow is composed of counter rotating square vortices arranged in a chessboard like array. The forcing function is carefully chosen to mimic experimental measurements of a laboratory realization, which is not purely sinusoidal as in the well-known Taylor Green vortex flow. The steadily forced flow leads to a statistically stationary state which is analyzed over a wide Reynolds number range. We analyze how the dynamics and flow structures change with increasing Reynolds number. We illustrate methods to discuss when and how the Q2D model ceases to accurately represent experiments.

**Area of Research Topic:** Fluid mechanics and turbulence

**Field of Investigation:** Quasi-two-dimensional flows

**ABOUT THE SPEAKER**

Abhishek Goyal is an M. Tech (Research) student in the Department of Mechanical Engineering, IISc, Bengaluru. He completed his B. E. from BITS Pilani, Hyderabad Campus in 2016. Subsequently he worked with L&T for Hyderabad Metro project where he looked after activities related to railway track and its interface with other systems. In 2021, he joined Prof Balachandra Suri's lab at IISc. His research interests are broadly in fluid mechanics and turbulence. He enjoys doing both experimental and numerical work and likes to crunch data from all possible angles. His other interests include reading fiction novels, swimming, running, and driving.