PMRF-ISSS Teaching Programme

Prime Minister Research Fellowship students' teaching requirement facilitated by the Institute of Smart Structures and Systems

Module PMRF-ISSS010/II/2026

Mathematical methods for turbulence

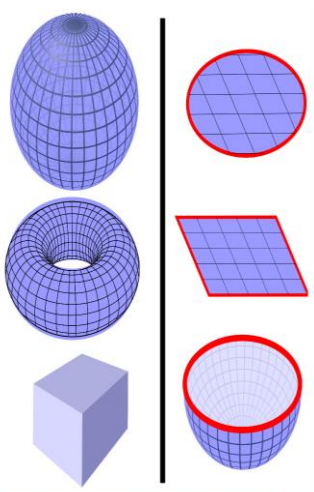
Name of the PMRF student

Sreenivas Saurab Kumar

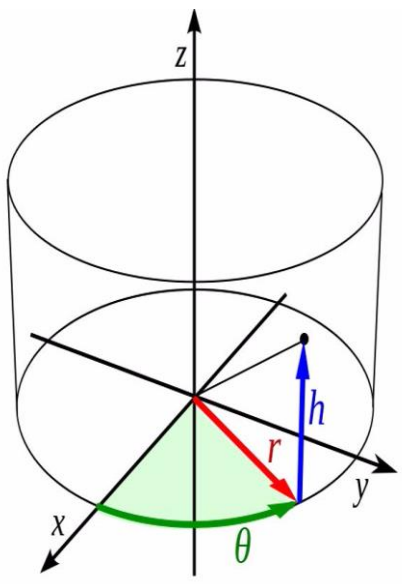
Required background of the students taught

Discipline(s)

Open to all, no prerequisites required. Mathematical methods are general and will be useful across all disciplines. The applicability of these methods will be explained in the context of fluid mechanics.



$$\rho\left(\frac{\partial \boldsymbol{u}}{\partial t}+(\boldsymbol{u}\cdot\nabla)\boldsymbol{u}\right)=\mu\nabla^2\boldsymbol{u}-\nabla p+\rho\boldsymbol{g}$$



$$\rho\begin{bmatrix}\frac{\partial u_r}{\partial t}+u_r\frac{\partial u_r}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_r}{\partial \theta}-\frac{{u_\theta}^2}{r}+u_z\frac{\partial u_r}{\partial z}\\ \frac{\partial u_\theta}{\partial t}+u_r\frac{\partial u_\theta}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_\theta}{\partial \theta}+\frac{u_r u_\theta}{r}+u_z\frac{\partial u_\theta}{\partial z}\\ \frac{\partial u_z}{\partial t}+u_r\frac{\partial u_z}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_z}{\partial \theta}+u_z\frac{\partial u_z}{\partial z}\end{bmatrix}=\begin{bmatrix}-\frac{\partial p}{\partial r}+\mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial (ru_r)}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u_r}{\partial \theta^2}-\frac{2}{r^2}\frac{\partial u_\theta}{\partial \theta}+\frac{\partial^2 u_r}{\partial z^2}\right]+\rho g_r\\ -\frac{1}{r}\frac{\partial p}{\partial \theta}+\mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial (ru_\theta)}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u_\theta}{\partial \theta^2}+\frac{2}{r^2}\frac{\partial u_r}{\partial \theta}+\frac{\partial^2 u_\theta}{\partial z^2}\right]+\rho g_\theta\\ -\frac{\partial p}{\partial z}+\mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u_z}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u_z}{\partial \theta^2}+\frac{\partial^2 u_z}{\partial z^2}\right]+\rho g_z\end{bmatrix}$$

Details of the content of the module

Overall structure and progression of the course:

The course shall be divided into three modules, namely

- Vector and Tensor analysis – A fairly advanced treatment of transformation laws, isotropy, metric tensors, Christoffel symbols and tensor calculus. *End goal: Manipulating terms in the Navier-Stokes equations and expressing it in any generalized coordinate system.*
- Fourier Analysis – Fourier series and transforms, real and complex representations. *End goal: Computing and plotting spectra, working in Fourier space.*
- Complex Analysis – Working with analytic functions, transformations in complex planes and conformal maps. *End goal: Using maps and transformations to simplify problems.*

Large emphasis on problem solving and application of these mathematical tools.

Schedule of the module

Start date: March 15th 2026, Sunday

Course Duration: 3 months

30-35 Lectures (Approx)

Meeting link : https://tinyurl.com/yf3jyftz

Contact email ID: sreenisaurab@gmail.com

Registration link: https://forms.gle/TyTHhFPTVuiqsLiu6