**JNC 315: Recent Trends in Inorganic and Nano Materials**
**(3.0 Credits)**

***Instructor: Dr. Pratap Vishnoi***

- **Extended inorganic solids:**
  Different types of complex metal oxides*;* perovskites ($ABO_3$), Ruddlesden–Popper*,* Dion-Jacobson, Aurivillius, Brownmillerite, hexagonal phases, Spinel and pyrochlore; synthesis, structure, band theory in solids, electronic properties, optical properties, transport properties, phonon properties; electrochemistry of transition metal oxides ($LiCoO_2$, $LiNiO_2$, $LiMn_2O_4$) and utility in energy storage.
  Antiperovskites and their functional properties.
  Metal pnictides; Skutterudites ($CoSb_3$ *etc.*), $Zn_4Sb_3$.
  Metal chalcogenides; $CuFeS_2$ (chalcopyrite), AgCuTe, $Bi_2Se_3$ and other complex chalcogenides.
  Intermetallics; Stoichiometric and non-stoichiometric, half Heusler, full Heusler compounds.
  Natrium Superionic CONductor (NaSiCON; e.g. $Na_{1+x}Zr_2Si_xP_{3-x}O_{12}$, $0 < x < 3$) compounds and ion conductivity in NaSiCONs.
  Topological insulator, topological crystal insulator, Dirac semimetal, Weyl semimetal.

- **Metal halides:**
  All-inorganic halide perovskites and hybrid halide perovskites, structural descriptors (tolerance factor and octahedral factor), layered metal halides ($\alpha$-$RuCl_3$), and their optical and topological quantum behavior. Chemical control over dimensionality (0D, 1D, 2D and 3D). Metal to metal charge transfer in mixed-valence metal halides and ligand to metal charge transfer in metal halides.

- **2D nanomaterials:**
  Introduction, structure, classification of 2D materials the compound and the elemental materials. Rise of various post-graphene elemental 2D materials; borophene, silicene, phosphorene, arsenene, antimonene etc. Binary, ternary and quaternary 2D materials; metal dichalcogenides ($MoS_2$, $MoSe_2$), metal phospho-chalcogenides ($Mn_2P_2S_6$, $AgInP_2S_3$), MXenes. Top-down approach for synthesis of 2D materials; liquid and electrochemical exfoliation Tuning properties of 2D materials by chemical functionalization, self-assembly and heterostructures. Electronic, transport properties, and lattice anharmonicity.

*Desirable prerequisites: basic knowledge of crystallography, ligand field theory, geometric aspects of metal complexes.*

**References**: recent literature