# MATRL 286K: Special Topics in Inorganic Materials; Non-metal to Metal Transitions

## Catalog Description:

The non-metal to metal transition in complex materials provides a continued challenge for our understanding, and more importantly, the phenomenon is associated with a vast array of useful materials properties, including transparent conductors, IR detectors, smart windows, superconductors, thermoelectrics, ... In this class, we will examine and rationalize experimental data, with a special focus on complex transition metal oxides.

## Teaching frequency:

Alternating years (hopefully).

## Target audience:

Ths is a graduate seminar course for students who have taken Materials 218, or can demonstrate equivalent knowledge.

## Prerequisites:

Materials 218 or equivalent.

## References:

The literature (current and past): See links on website.

*Introduction to Solid State Physics* (8th Edn.) by C. Kittel.

*The Electronic Structure and Chemistry of Solids* by P. A. Cox.

*The Physics of Amorphous Solids* by R. Zallen.

## Instructor:

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## Course Website:

http://www.mrl.ucsb.edu/∼seshadri/teach.html

## Grading:

Based on seminars by student during the course of the class.

## Outline (no particular order):

1. Counting electrons in valence-precise compounds: Band Insulators.
2. Metals and why they exist. Screening. Separating the periodic table using the Herzfeld criterion.
3. Filling and the Mott criterion. Correlation and bandwith.
4. Percolation.
5. Disorder and the Anderson localization.
6. Bonding and non-metal to metal transitions, the example of $VO_2$..
7. Thermal and pressure effects.
8. Composition control: Filling *vs.* bandwidth.
9. Structural control of bandwidth.
10. Examples of doped perovskites, R–P phase, pyrochlores, ...
11. Dimensional control in R–P phases
12. Manifestations: Colossal Magnetoresistance, charge-ordering, superconductvity, ...