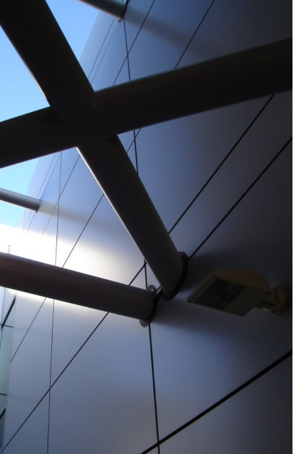

MECHANICAL ENGINEERING

DISSERTATION DEFENSE

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Arman Haghighi

Tuesday, December 5, 2017, 11:00AM in Bourns Hall A341

Novel heat removal enhancement and reduction and optimized surface treatments for Several Engineering Applications

Doctor of Philosophy, Graduate Program in Mechanical Engineering
University of California, Riverside, December 2017
Dr. Kambiz Vafai, Chairperson

Metallic foams have increasingly gained a lot of attention due to their superior structural, acoustic, mixing and filtering characteristics. To substantially further enhance the thermal features of these materials, metallic porous structures of various geometries is introduced inside a channel, which are usually used as heat sinks. The challenge is to enhance the heat transfer rate from the heated wall to the working fluid while minimizing the pressure drop penalty caused by implementing these structures. Various metallic foams with different values of Porosity (Ẏ), Pore diameter (d_p), Permeability (K), and Aspect Ratios (AR) are studied for the most common working fluids used in practical applications. In addition, the effect of emplacement of an array of these structures are studied and analyzed. The optimum conditions yield Nu enhancement ratios as high as 4.5 to 8 times compared to the case of a channel with no structural enhancement. These enhancements are achieved with pressure drop ratios as low as 2. Our results demonstrate that thermal performance of metal foams can be substantially enhanced for heat removal in applications for solar collectors, compact heat exchangers, electronic cooling, etc. for a only modest increase in the pressure drop.

The second part of this work, addresses the issue of natural convection in cavities which is widely found in cooling electronics devices, heat exchangers, solar thermal collectors, heating and ventilating applications and energy conservation in refrigeration units. Enhancements and implementations of the insulating features in a cavity are analyzed. Heat transfer reduction capabilities of a vertical or a horizontal adiabatic partial partition fixed in a differentially heated cavity are analyzed. The effects of length and location of the partition is taken into account for aspect ratios from 1 to 4 and for Rayleigh numbers from 10^3 to 10^6. Different characteristics of square and higher aspect ratio cavities are compared and a comprehensive correlation of the heat transfer reduction is introduced, incorporating all the pertinent parameters. The optimized configurations and features for insulating a given cavity are established and discussed.