WEEK 5

QUESTION 1: In your own words write a summary of the topics about radiative heat transfer we went through including the definitions of emissivity, absorptivity and reflectivity, the view factor, the heat exchange between two black surfaces, the heat exchange between the two gray surface and finally the definition of radiative resistances.

ANSWER 1:
Emissivity: Emissivity is defined as the ratio of the energy radiated from a material's surface to that radiated from a perfect emitter, known as a blackbody, at the same temperature and wavelength and under the same viewing conditions. It is a dimensionless number between 0 (for a perfect reflector) and 1 (for a perfect emitter).

Absorptivity: Absorptivity refers to the ratio of the absorbed heat to the total energy of the projected heat onto the object. The object that can absorb all the rays is a black body, and its absorption rate is 1. The absorption rate of the actual object is less than 1, depending on the material, roughness and temperature of the surface of the object and is related to the wavelength range and angle of incidence of the received heat rays.

Reflectivity: Reflectivity is an optical property of material, which describes how much light is reflected from the material in relation to an amount of light incident on the material. The reflection occurs always on the surface of the material, for the light-diffusing (translucent) materials also in the volume of the material.

The view factor: The view factor F12 is the fraction of energy exiting an isothermal, opaque, and diffuse from surface 1 (by emission or reflection), that directly to the surface 2.

The heat exchange between two black surfaces: The two black surfaces will constantly absorb and emission all the radiation. Suppose there are two black surfaces with given area, A1 for the first object and A2 for the second object. So the energy leaving the first object and the second object are Eb1A1 and Eb2A1. The energy leaving object 1 that arrive the object 2 is Eb1A1F1-2 and the for the object 2 in this situation is Eb2A2F2-1. The net energy interchange from body 1 to body 2 is Eb1A1F1-2 - Eb2A2F2-1 = Q1-2

The heat exchange between two grey surfaces: The two grey surfaces will absorb and reflect a certain fraction of radiation. The reflect part will also constantly absorb by the other side for a certain fraction and reflect the other radiation, and the same thing happens in the other surface. The radiation will generally lose its power during the process.

Radiative resistance: It is the resistance of a particular medium or system to the flow of heat through its boundaries and is dependent upon geometry and thermal properties of the
medium such as thermal conductivity.

QUESTION 2: Find the radiative heat transfer between surface 1 and 2. The area is 1.5 ㎡, ε1 = 0.2, ε2 = 0.7, T1 = 37℃, T2 = 17℃. After that, compare the results when ε1=ε2=0.1 and what can you conclude from that result?

ANSWER 2:

$\sigma=5.67*10^{-8}W/㎡\ K^4$ T1 = 37℃ = 310K T2 = 17℃ = 290K

According to the formula:

$\dot{Q}_{net_{2-1}}$ = Aσ($T2^4$- $T1^4$)/1/ε_1+1/ε_2-1 = 1.5*5.67*10^{-8} (310^4-290^4) /1/0.2+1/0.7-1 = 33.8763W

When ε1=ε2=0.1, then:

$\dot{Q}_{net_{1-2}}$ = Aσ($T1^4$- $T1^4$)/1/ε_1+1/ε_2-1 = 1.5*5.67*10^{-8} (310^4-290^4) /1/0.1+1/0.1-1 = 9.6789W

From above we could see that the value of emissivity will significantly change the total number of radiative between two grey surfaces.