EXAM III
HEAT TRANSFER

June 25, 2014

I. Explain the following terms: (18%)
(1) Gray body
(2) Emissivity
(3) F_{12}
(4) Space resistance
(5) Solid angle
(6) Kirchhoff's law

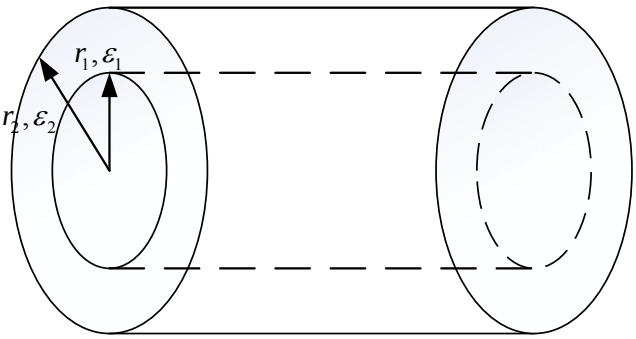
II. 簡答題: (33%)

1. 何謂溫室效應？為何二氧化碳(CO_2)濃度升高會使地表溫度上升？
2. 以熱輻射觀點，如何提高太陽能電池之效率？
3. 一般市售保溫鋼瓶是用哪些方式來達到絕熱，請以傳導、對流、輻射三個角度說明。
4. 請以熱輻射的角度說明在夏天中為何鐵皮屋會比一般房屋來的悶熱？有哪些方法可以改善？
5. 請以熱輻射的角度說明汽車用的隔熱遮陽板放置在擋風玻璃外側還是內側能最有效的防止車內溫度上升？為什麼？
6. 以熱輻射觀點，簡述為何有些影像擷取儀器可以看穿衣服？
7. A non-transparent shield is put between two surfaces. The radiation from the first surface cannot be transmitted through the shield and neither can the radiation from the second surface. If the temperature of the first surface is higher than that of the second one, the second surface can still receive a net radiation energy. Why?
8. 在烈日之下，為何在樹下比在遮雨棚下更涼爽？
9. Why do people wear dark-color clothes in winter?
10. In what condition is F_{ii} equal to zero?
11. Should the emissivity of a radiation shield be large or small? Why?

III. Two large parallel planes are at T_1=800K, $\varepsilon_1 = 0.3$, T_2=400K, $\varepsilon_2 = 0.7$ and are separated by a gray having $\varepsilon_g = 0.2$, $\tau_g = 0.8$.

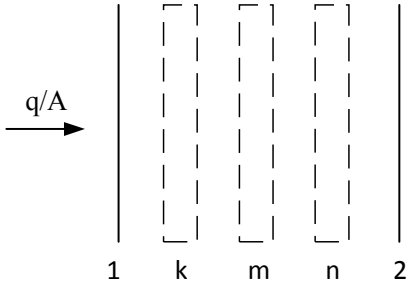
(a) Calculate the heat-transfer flux $\left(q/A, W/m^2\right)$ between the two planes with gas. (4%)
(b) Calculate the temperature of the gas. (4%)
(c) Calculate the heat-transfer flux $\left(q/A, W/m^2\right)$ without the presence of gas. (4%)

IV. Consider the radiation heat transfer only. Derive the expression of $q_{1\text{-}2}$ of two long (infinite) concentric cylinders, as shown in the following figure. (7%)

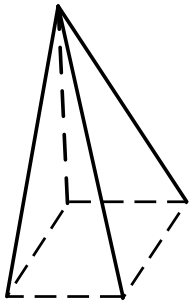


V. As shown in the folloing figure, a radiation system consists of five transmitting media between two planes.

(a) Derive the expression of the net radiation exchange by transmission between surface 1 and 2. (5%)
(b) Deriver the expression of the net radiation energy exchange between k and 2. (5%)



VI. Determine the shape factors from the base of the pyramid shown in the following figure to each of its four side surface. The base of the pyramid is a square, and its side surface are isosceles triangles(等腰三角形). (8%)

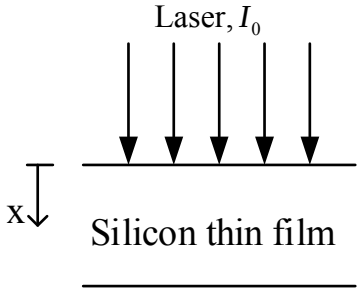


VII. A laser irradiates on a thin silicon film, shown in the following figure. The temperature of the film is function of x and time. Prove that the heat diffusion of the film can be expressed as

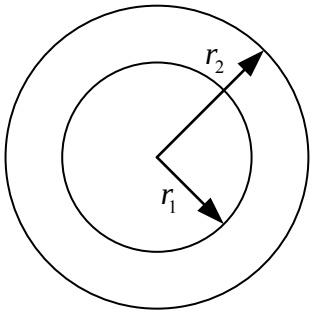
$$\rho C_p \frac{\partial T}{\partial t} = \frac{\partial}{\partial x}\left(k \frac{\partial T}{\partial x} \right) + I_0 \kappa e^{-\kappa x}$$

Where I_0 is the laser intensity (power per unit area) at x=0 and κ is the absorption coefficient.

Hint: Beer's law $\left(I_x = I_0 e^{-\kappa x}\right)$ can be used to prove the equation. (10%)



VIII. Consider an enclosure composed of two concentric spheres as illustrated in following the figure. Find F_{12} and F_{21}. (7%)



IX. An un-transparent flat surface has the area of A_1 and the temperature of T_1. The surface is put on the floor of a big room, whose area and temperature are A_2 and T_2, respectively. A_2 is much large than A_1.

(a) If the surface is block body, what's the radiation heat transfer between the surface and the room? (4%)

(b) If the surface is gray and diffuse with the emissivity of ε_1, what's the radiation heat transfer between the surface and the room? (4%)

(c) The surface is square like the base of the pyramid and a radiation shield of pyramid-side shape is put on the surface (shown in the figure of Problem VI). The area and emissivity of the shield is A_3 and ε_3. If the surface is gray and diffuse with the emissivity of ε_1, what's the radiation heat transfer between the surface and the room? (7%)