National Exams December 2017

04-Agric-A3, Heat Engineering

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. Four (4) questions constitute a complete exam paper.
   The first four questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. All questions require calculation.

Problem 1(25 points)

The front of a slab of lead (k=35 W/ m. K) is kept at 110°C and the back is kept at 50°C. If the area of the slab is 0.4 m^2 and it is 0.03 m thick, compute the heat flux q, and the heat transfer rate, Q.

Problem 2(25 points)

a) If 200 cm^3 of tea (specific heat=4186 J/Kg C , density=1000 Kg/m^3) at 95°C is poured into a 150-g glass cup (specific heat =840 J/Kg C) initially at 25°C, what will be the final temperature T of the mixture when the equilibrium is reached, assuming no heat flows to the surroundings?

b) Determine the amount of heat necessary to raise the temperature of 1 Kg of aluminum (specific heat=0.9KJ/Kg K) from 30°C to 100°C.

c) A block of solid of mass 2Kg is heated from 300K to a final temperature of 550 K by transferring 50 KJ of heat from a reservoir at 1000K. Determine the specific heat of the solid

Problem 3(25 points)

A physics experiment uses liquid nitrogen as a coolant. Saturated liquid nitrogen at 80K flows through 6.35 mm O.D stainless steel line (emissivity ε_l=0.2) inside a vacuum chamber. The chamber walls are at T_c=230K and are at some distance from the line.

Determine the heat gain of the line per unit length.

If a second stainless steel tube, 12.7 mm in diameter, is placed around the line to act as radiation shield

Determine the revised heat gain per unit length.

Hint: Assume that the chamber area is large compared to the shielded line.

Problem 4 (25 points)

Two black disks of diameter 2ft are placed directly opposite one another at a distance of 4ft. Disk 1 is maintained at 2000°R, and disk 2 at 1000°R. Calculate the heat flow between the two disks for two conditions;

1. When no other surfaces are present

2. When the two disks are connected by an adiabatic right-cylinder back surface

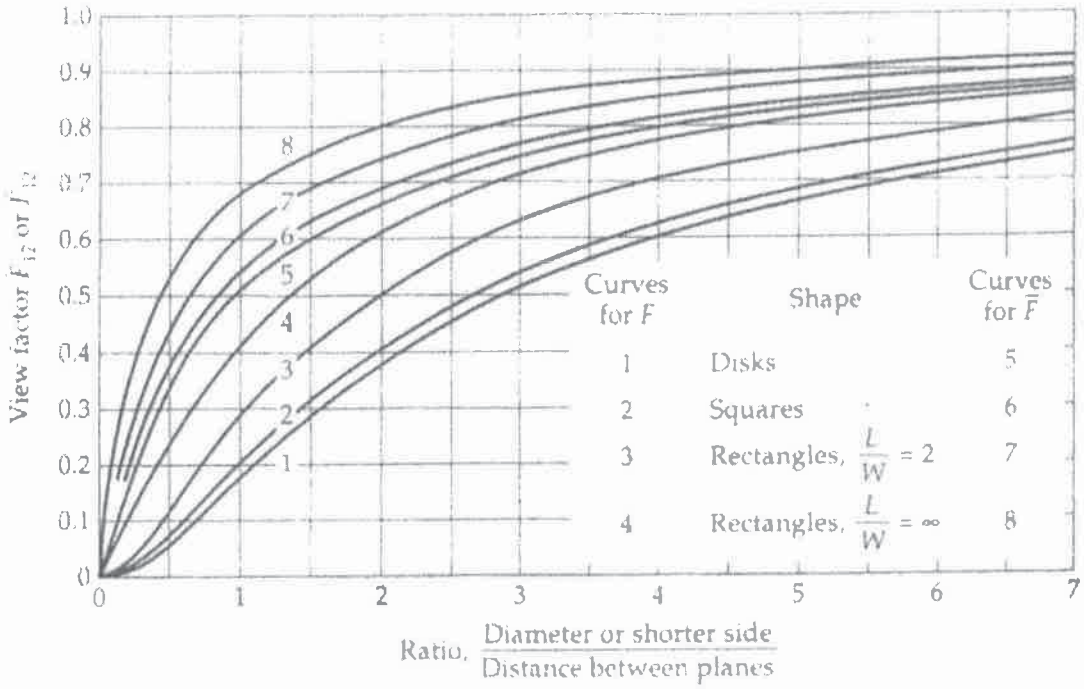

Figure 1. View factors for direct radiation between opposed identical shapes in parallel planes.