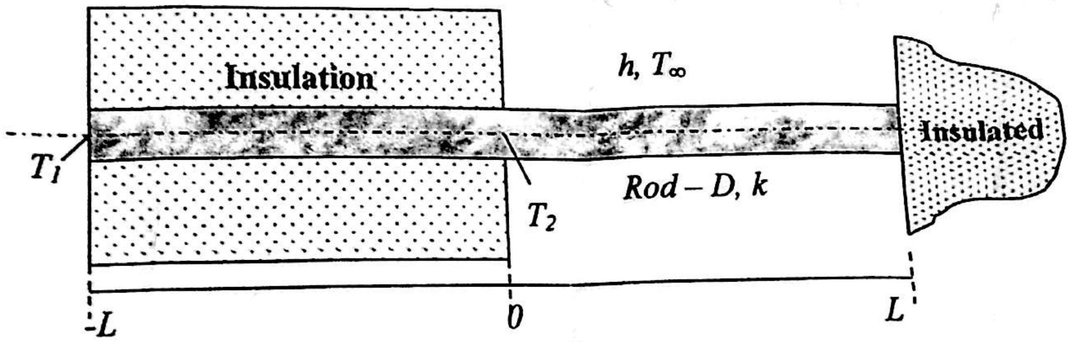
Indian Institute of Technology, Kharagpur
Mechanical Engineering Department

Heat Transfer – Autumn Semester 2016
Class Test - 1

1. Consider steady heat transfer between two large parallel plates kept vertically with an intermediate gap of 1.0 cm. One of the plates is maintained at 300K while the other is at 200K.
   a) Assuming the surfaces to be black (emissivity =1.0) and the gap is filled by air, find out the rate of heat transfer. What will the rate of heat transfer be if the space between the two plates is evacuated?
   b) Consider the plates are now kept horizontally maintaining the same gap and same temperatures, once (i) with the hot plate at the top and then (ii) with the cold plate at the top. Again there could be two cases - either the gap between the plates is filled with air or evacuated. For all these cases , how will the rate of heat transfer change compared to the values estimate by you for (1.a)? Give justifications; *no numerical calculations are needed.* 20

2. Consider a rod of diameter *D*, thermal conductivity *k*, and length *2L* that is perfectly insulated over the first half of its length while the other half is exposed to the atmosphere.
   a) Sketch the temperature distribution on *T-x* coordinates and identify its key features. Assume $T_1 > T_\infty$.
   b) Derive an expression for the midpoint temperature T_2 in terms of the geometric and thermal parameters of the system.



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3. A body of volume *V*, surface area *A*, density ρ and specific heat C_p is initially at a temperature T_o. The body is immersed at $t=0$ is a fluid reservoir at $T_o + \Delta T$. At time $t = t_1$ it is taken out from the hot fluid reservoir and plunged into a cold reservoir at $T_o - \Delta T$. Derive an expression for time t_2, when the body returns to its original temperature T_o. Show that the time spent in the cold fluid can never be greater than the time spent in the hot fluid. Assume the heat transfer coefficient to be the same for both reservoirs and Bi<0.1. 20

Useful data

Stefan Boltzmann constant:	5.667×10^{-8} W/m^2-K^4
Thermal conductivity of air:	0.025 W/m-K