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| 1 ) Two stainless steel plates 10 mm thick are subjected to a contact pressure of 1 atm under vacuum conditions for which there is an overall temperature **drop of 100◦C** across the plates. What is the **heat flux through the plates**? What is the **temperature drop** across the contact plane? Hint: Use the contact conductance value in Table 2.1. | . x R1 Rconect R2 |

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| 2) A stainless steel (AISI 304) tube used to transport a chilled pharmaceutical has an inner **diameter of 36 mm** and a wall thickness **of 2 mm**. The pharmaceutical and ambient air are at **temperatures of 6◦C and 23◦C,** respectively, while the corresponding inner and outer convection coefficients are **400 W/m2-K** and **6 W/m2-K**, respectively.  (a) What is the heat gain per unit length [W/m]?  Outside 23◦C  6◦C | 18mm  (b) What is the heat gain per unit length if a **10** mm thick layer of calcium silicate insulation (**kins = 0.05 W/m-K**) is applied to the outside of the tube? |

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| 3) Steam at a temperature of **250◦C flows** through a steel pipe (AISI 1010) of **60 mm inner** diameter and **75 mm outer diameter**. The **convection coefficien**t between the steam and the **inner** surface of the pipe is **500 W/m2-K,** while that between the **outer** surface of the pipe and the surroundings is **25 W/m2-K.** The pipe emissivity is 0.8, and the temperature of the air and surroundings is **20◦C**. What is the heat loss per unit length of pipe? | Radiation  **250◦C**  Convection  **20◦C**  | 🡨30 mm 🡪| 🡨7.5🡪|  Steam Steel |

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| 4) A **spherical** shell of inner and outer radii of ri and ro, respectively, is filled with a heat-generating material that provides for a uniform **volumetric generation rate (W/m3) of q ̇.** The outer surface of the shell is exposed to a fluid having a temperature **T∞** and a convection coefficient **h**. Obtain an expression for the steady-state temperature distribution **T(r)** in the shell, expressing you results in terms of **ri, ro, q ̇, h, T∞,** and the thermal **conductivity k** of the shell material.  | 🡨 Ro 🡪 |    | 🡨 Ri 🡪 | | https://images.app.goo.gl/BBty8fw2MHekAYDT7  Image result for hollow shell cross section |

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| 5. The exposed surface (x = 0) of a plane wall of thermal conductivity k is subjected to microwave radiation that causes volumetric heating to vary as    where q ̇o (W/m3) is a constant. The boundary at x = L is perfectly insulated, while the exposed surface is maintained at a constant temperature To. Determine the temperature distribution T(x) in terms of x, L, k, q ̇o, and To. |  |

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| 6) A long cylindrical rod of diameter **200 mm** with thermal conductivity of **0.5 W/m-K** experiences uniform volumetric heat generation of **24,000 W/m3.** The rod is encapsulated by a circular sleeve having an outer diameter of **400 mm** and a thermal conductivity of **4 W/m-K.** The outer surface of the sleeve is exposed to a cross flow of air at **27◦C** with a convection coefficient of **25 W/m2-K**.  (a) Find the temperature at the interface between the rod and sleeve and on the outer surface. | (b) What is the temperature at the center of the rod? |

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| 7) Radioactive waste **(krw = 20 W/m-K)** is stored in a spherical, stainless steel **(kss = 15 W/m-K)** container of inner and outer radii of **ri = 0.5** m and **ro = 0.6 m**, respectively. Heat is generated volumetrically within the waste at a uniform rate of **q ̇ = 105 W/m3**, and the outer surface of the container is exposed to a water flow for which **h = 1000 W/m2-K** and **T∞ = 25◦C**.  (a) Evaluate the steady-state outer surface temperature of the container, **Ts,o**.    (c) Obtain an expression for the temperature distribution, **T(r)** in the radioactive waste. Evaluate the temperature at **r = 0**. | https://images.app.goo.gl/BBty8fw2MHekAYDT7  Image result for hollow shell cross section  (b) Evaluate the steady-state inner surface temperature of the container, **Ts,i**. |  |