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| 1. One-dimensional, steady-state conduction without heat generation occurs in a plane wall (T1 on left and T2 on right). The thermal conductivity (k) is 5 W/m2 and the thickness (L) is 0.1 m. Determine the unknown quantities for each case in the table below and sketch the temperature distribution and indicate the direction of the heat flux for each. | |  |  |  |  |  | | --- | --- | --- | --- | --- | | case | T1 | T2 | dT/dx [K/m] | q'' [W/m^2] | | 1 | **673** | 573 | -1000 | 5000 | | 2 | **100** | 75 | -250 | 1250 | | 3 | 80 | **100** | 200 | -1000 | | 4 | **75** | -5 | -800 | 4000 | | 5 | 30 | **90** | 600 | -3000 |  |  |  |  | | --- | --- | --- | | T1 | Degrees Celus | T2 | | 673  100  80  75  30 |  | 573  100  75  -5 | |

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| 1. A solid cylindrical rod of   length (L) 0.1 m and  diameter (d) 25 mm  is well insulated on its side, while the end faces are maintained at  temperatures of 100◦C and 0◦C.  What is the rate of heat transfer through the rod if it is constructed from  (a) pure copper,  (b) aluminum alloy 6061-T6,  (c) AISI 304 stainless steel,  (d) fused silica glass (SiO2),  (e) wood (oak),  (f) magnesia, 85%, and  (g) Silica aerogel?  Use the properties tables at the end of the book | |  |  |  | | --- | --- | --- | | T1 |  | 100 | | T2 |  | 0 | | D |  | 0.025 | | L |  | 0.1 | |  | K values | q | | (a) pure copper, | 398 | 195.367793 | | (b) aluminum alloy6061-T6, | 167 | 81.9759333 | | (c) AISI 304 stainless steel, | 13.8 | 6.77405916 | | (d) fused silica glass (SiO2), | 1.41 | 0.69213213 | | (e) wood (oak), | 145 | 71.1767086 | | (f) magnesia, 85%, and | 0.067 | 0.03288855 | | (g) Silica aerogel? | 0.022 | 0.01079922 | |

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| 3. Uniform internal heat generation at **q ̇ = 5 × 107 W/m3** is occurring in a cylindrical nuclear reactor fuel rod of 50 mm diameter, and under steady-state conditions the temperature distribution is of the form **T(r) = a+br2**, where T is in degrees Celsius and r is in meters, while **a = 800◦C** and **b = −4.167 × 105◦C/m2**. The fuel rod properties are **k = 30 W/m-K, ρ = 1100 kg/m3**, and **cp = 800 J/kg-K**.  (a) What is the rate of heat transfer per unit length of the rod at **r = 0** (the centerline) and at **r = 25 mm** (the surface)?  (b) If the reactor power level is suddenly increased to **q ̇2 = 108 W/m3**, what is the initial time rate of temperature change at **r = 0** and **r = 25 mm**? |  |

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