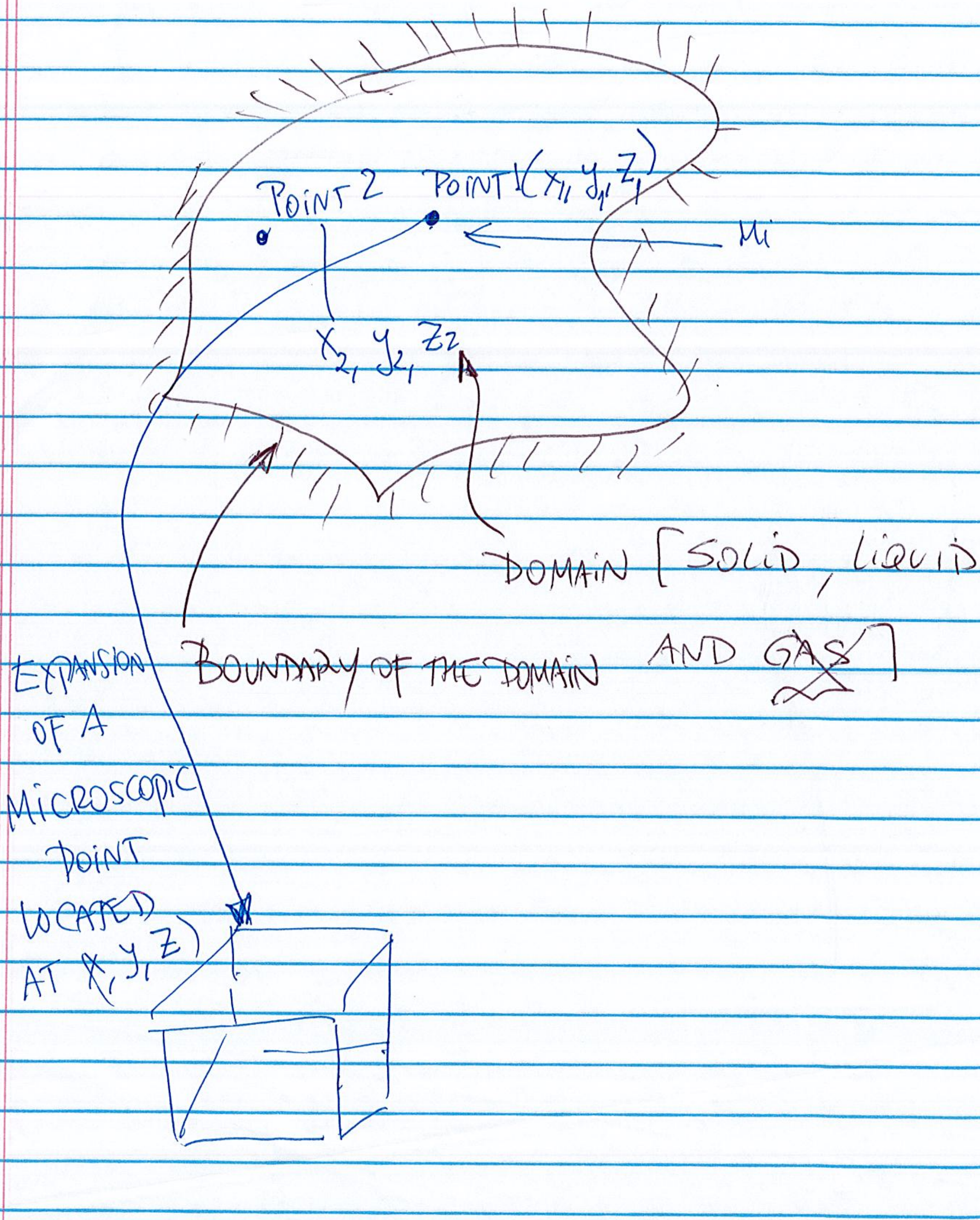
ABE 308 CLASS 1-16-2018



(2)

Flow [Watts]

$$q_x = -KA\frac{dT}{dx} \quad \text{[FOURIER LAW]}$$

[m^2]

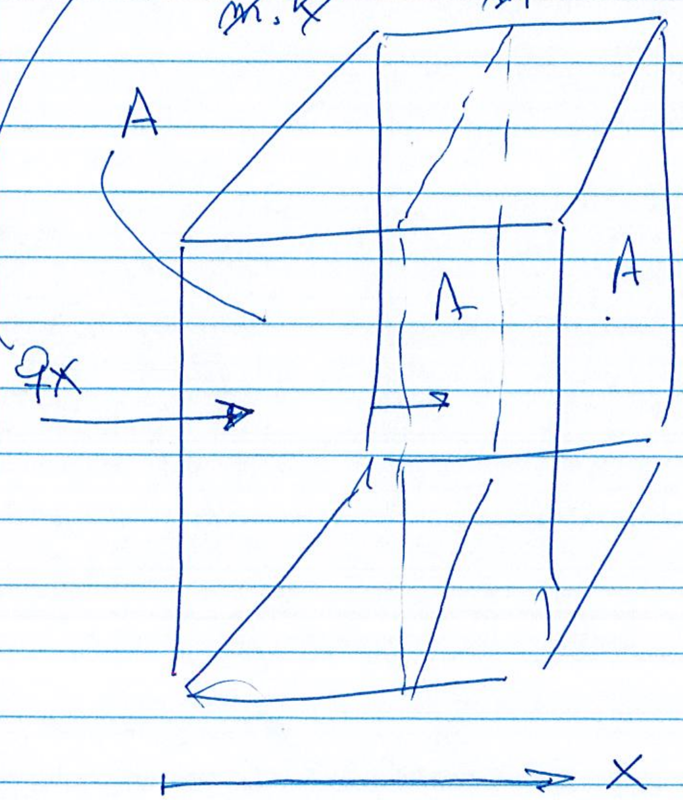
K

m

thermal conductivity $\left[\frac{W}{m.K}\right]$

$$\frac{W}{\cancel{m}.\cancel{K}} \cdot \cancel{m^2} \times \frac{\cancel{K}}{\cancel{m}} = \text{Watts}$$

A: cross-sectional area to the flow



$$\text{FLUX} = \frac{\text{Flow}}{\text{Area}} = \frac{W}{m^2} = \frac{q_x}{A} = -\frac{K\cancel{A}\,dT}{\cancel{A}\,dx} = q_x''$$

If in your problem Area (A) is unknown it is better to calculate the ~~flow~~ FLUX

FLOW IN THE DIRECTION X

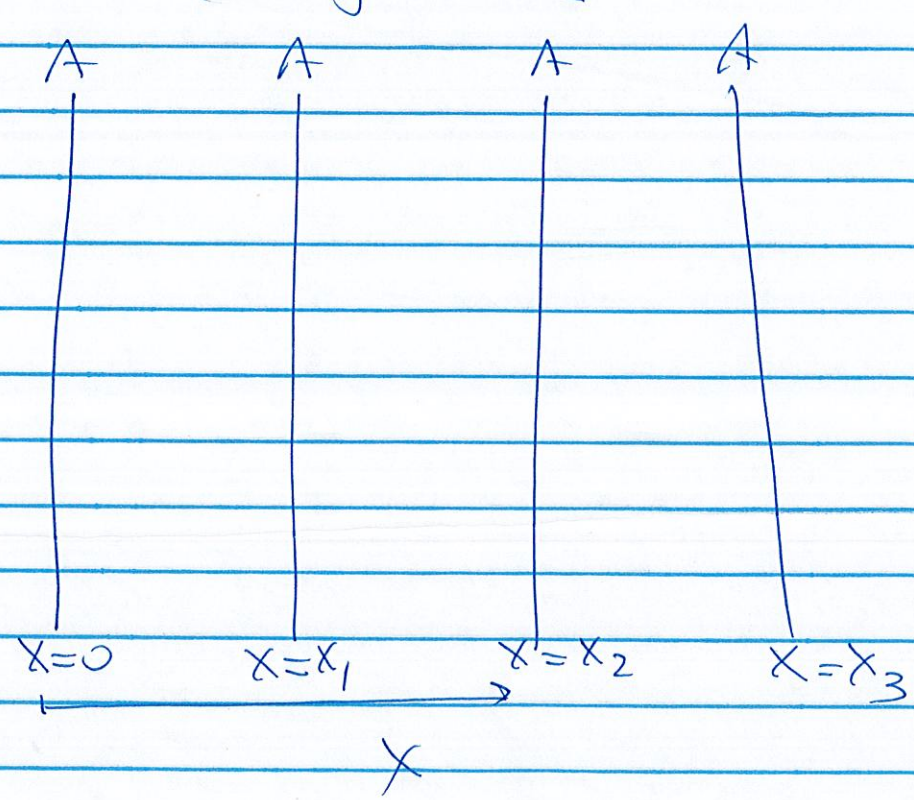
FLOW $q_x = -KA\frac{dT}{dX}$

GRADIENT OF TEMPERATURE

IT IS ALWAYS NEGATIVE

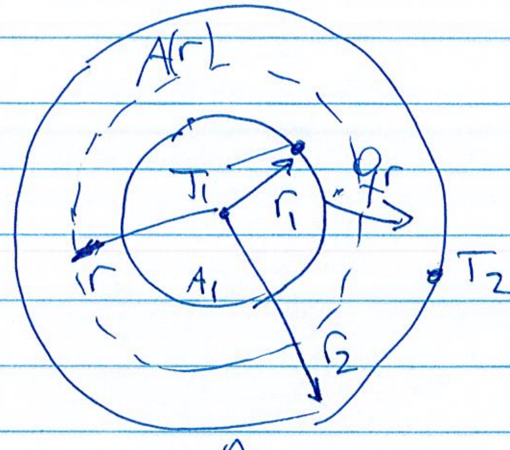
FLUX $\frac{q_x}{A} = -K\frac{dT}{dX} = q''_x$ ← that indicates is a flux.

CARTESIAN COORDINATES Area is the same at any location



(4)

$T_1 > T_2$

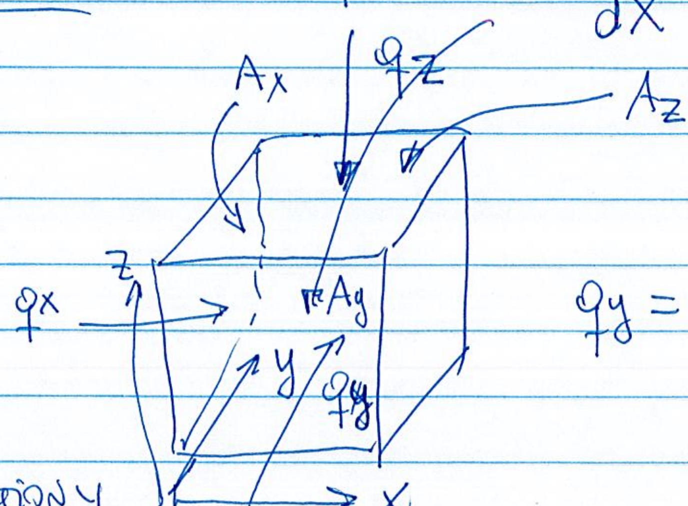


$A_1 < A_2 > A(r)$

For spherical or cylindrical geometries
Areas $A(r)$ are a function of r

FOURIER LAW

DIRECTION X $\quad q_x = -K_x A_x \dfrac{dT}{dX}$



$$q_y = -K_y A_y \frac{dT}{dy}$$

DIRECTION y

DIRECTION Z

$$q_z = -K_z A_z \frac{dT}{dZ}$$

For a 3D HEAT TRANSFER PROBLEM

Gradient operator

$$\vec{q}'' = \frac{\vec{q}}{A} = -K \nabla T$$

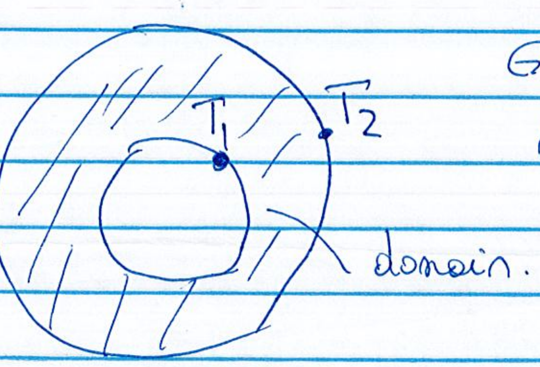
Let's assume Isotropic material $K_x = K_y = K_z = K$

operator scalar

$$\nabla T = \frac{\partial T}{\partial x}\underline{i} + \frac{\partial T}{\partial y}\underline{j} + \frac{\partial T}{\partial z}\underline{K}$$

CONDUCTION IN A SPHERE

$$\frac{\partial T}{\partial t} = \underbrace{\frac{K}{\rho C}}_{\alpha} \left[\underbrace{\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial T}{\partial r}\right) + \cancel{\frac{1}{r^2\sin^2\theta}\frac{\partial^2 T}{\partial \phi^2}} + \cancel{\frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}(}}_{\text{CONDUCTION}} \right]$$



GOOD AND A "REALISTIC" ASSUMPTION IS THAT Temperatures changes only with r