

Orientation

창원대학교 신소재공학부

정영웅



yjeong@changwon.ac.kr
<https://youngung.github.io>
<https://github.com/youngung>

공돌이와 정량화

- 정성적, 정량적
- 정량화(quantification)란?
- 왜 공돌이는 정량화를 좋아하나?
- 얼마나 정확한 정량화를 해야하나?
- 그렇다면, 왜 수학이 공학에서 중요한 역할을 할까?
 - 물리적 현상을 수학적 모형으로 표현
 - 복잡한 형상, 조건을 수학적 모형으로 통해서 재현
 - 수학 모형을 사용해 물리현상, 물리량의 정량적인 값을 예측
- 왜 예측이 필요하나?
 - 돈
 - 돈
 - 돈



What you expect from this lecture

□ Physical entities we are dealing with

➤ Momentum

- ❖ Viscosity (Newtonian fluid)

➤ Energy

- ❖ Heat conduction (Fourier's law)

➤ Mass

- ❖ Molecular diffusion (Fick's law)

□ Physical phenomena we are interested in:

- Flow of fluids; flow of heat, and flow of mass.

□ Physical properties we are interested in:

➤ Viscosity

➤ Thermal conductivity

➤ Diffusion coefficient

□ Disciplines

➤ Fluid statics (and dynamics)

➤ Heat transport

➤ Mass diffusion

□ Why?

- The above three topics are described in the same (or similar) mathematical methodology.



Conservation principle

- $\text{Input} + \text{Generation} = \text{Output} + \text{Depletion} + \text{Accumulation}$
- If at steady state (시간에 따른 변화가 없는 정상상태),
 - Accumulation = zero



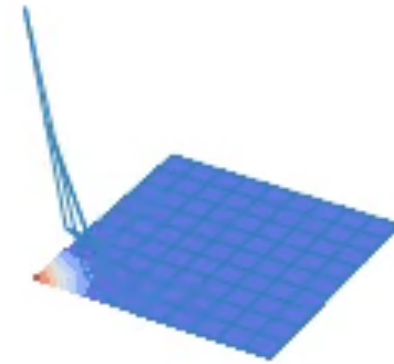
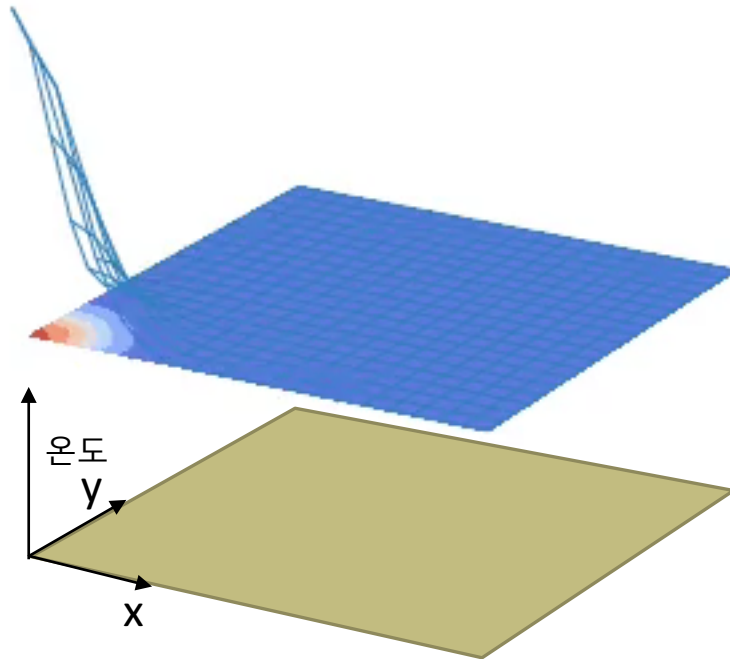
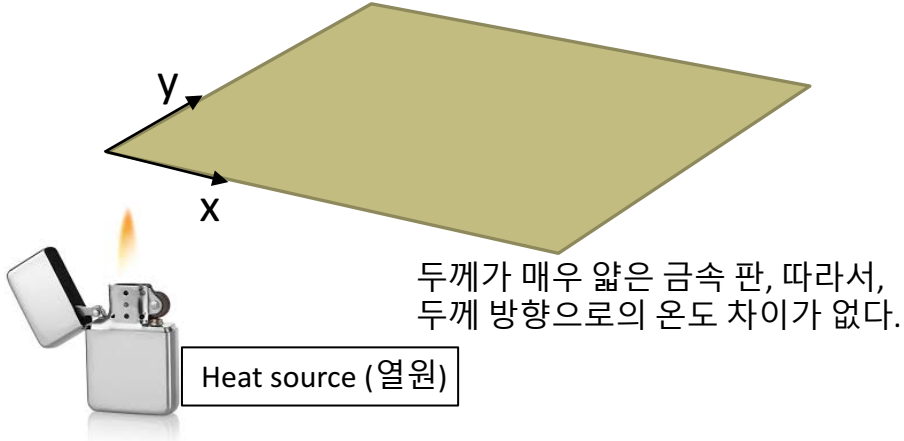
Mathematical frameworks

□ Mathematical prerequisites

- Scalars
- Vectors (and possibly tensors)
- Coordinate systems (Rectangular, cylindrical, spherical)
- Gradient of a scalar field
- Dot products of two vectors
- Directional derivatives

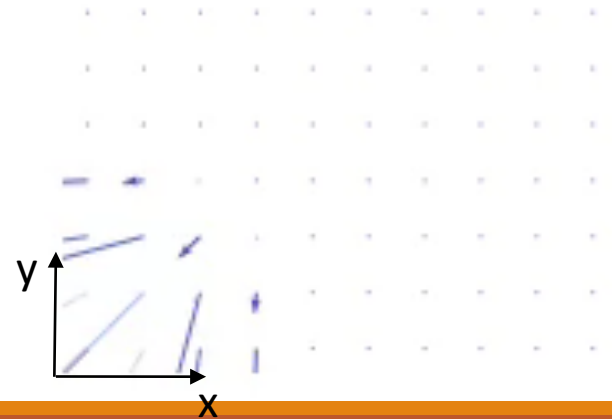


Scalar Gradient; Vector Gradient

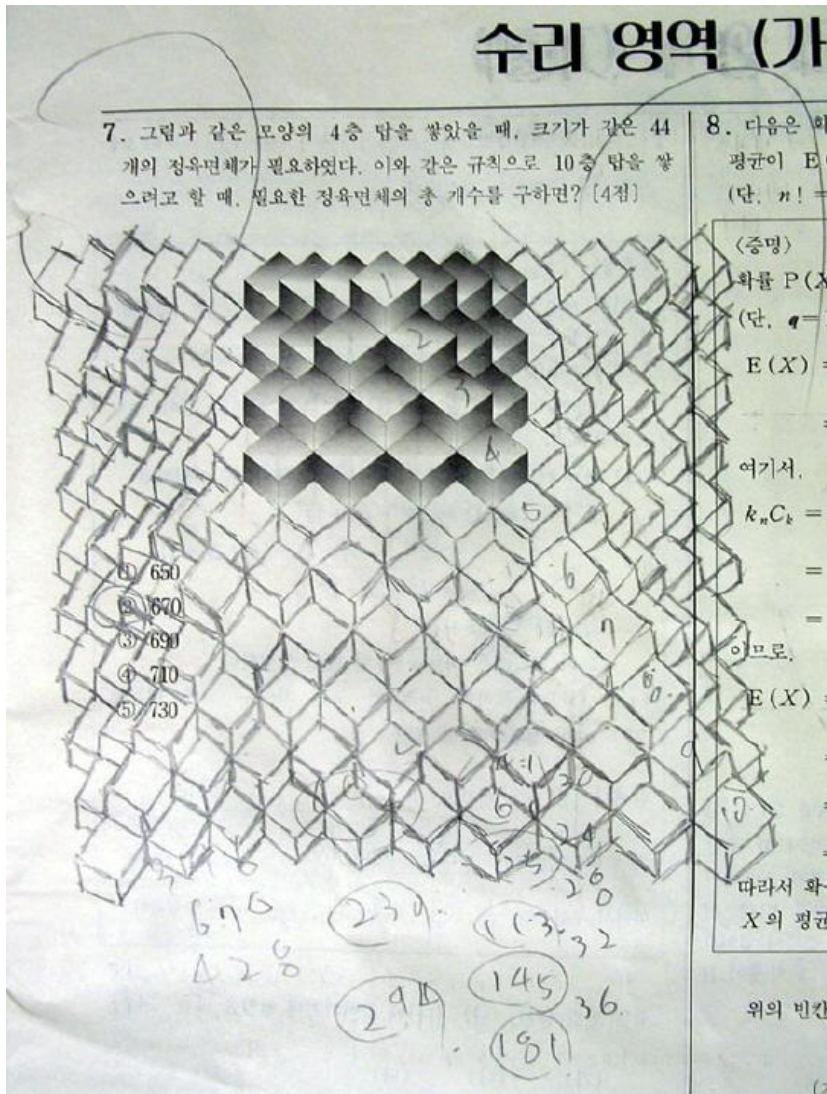


Temperature gradient: $\left(\frac{\partial T}{\partial x}, \frac{\partial T}{\partial y}\right)$

Temperature gradient itself is a field variable
온도 구배 자체가 공간(여기서는 x,y space)에
따라 다른 값을 가질 수 있다.



수학적 모델링



Step

No. in that layer

1

1

2

1+4

3

1+4+8

4

1+4+8+12

5

1+4+8+12+16 ...

$$1 \cdot 10 + (4 \cdot 1) \cdot (10-1) + 4 \cdot 2 \cdot (10-2) + 4 \cdot 3 \cdot (10-3) + 4 \cdot 4 \cdot (10-4)$$



References

- 재료공학의 이동현상 개론 (D. Gaskell)
- Transport Phenomena (Bird, Stewart, Lightfoot)
- Advanced transport phenomena (P. A. Ramachandran)

