

GEOL 595 - Geodynamics
Midterm, April 21, 2011

WHAT TO BRING to the Exam:

- Pencil and/or pen
 - Half sheet of paper with notes (4" x 11") on one side only
 - Calculator
- (Scratch paper will be provided)

I. Geodynamics

- What is Geodynamics ?
- How do Geodynamicists approach geological problems ?
- What are the 3 types of modeling techniques used ?
- Give examples of typical problems

II. Tectonic Plates

- Crust
- Lithosphere
- Lithosphere formation, cooling rate
- Asthenosphere
- Styles of deformation in each of the above
- A major reason why scientists resisted the hypothesis of "Plate Tectonics" ?
- What drives plate motion (3 things) ? Explain each.

III. Heat Energy

- If Earth was hotter in the past, what processes act to cool the Earth ?
- Name the 3 processes of heat transport.
- What modes of Heat flow did Lord Kelvin assume to calculate the age of the Earth ?
- Why were Lord Kelvin's estimates different from what we know today ?
- Describe *Heat Conduction* (in words, equation, and a sketch)
- Understand the *Steady State* and its Time-Dependent conduction equation
- Two observations that show oceanic lithosphere forms by conductive cooling
- Know how heat flow and depth of the lithosphere relate to seafloor age.
- What is *diffusion time* ?
- What is thermal diffusivity, κ ?
- How are the two (above) related ?

IV. Fourier transforms

- What is it ?
- How are they used ?
- Fourier synthesis
- Fourier analysis
- Write a Fourier Series

V. Stress

- Define a solid and a liquid
- Define a plastic material
- What is stress ? Define, draw a sketch.
- Name 3 types of stress
- How is stress related to strain in a viscous fluid ? Give equation
- What does *Conservation of Mass* tell us about fluid ?
- What is Hydrostatic, Deviatoric, and Lithostatic stress ?
- Typical value for deviatoric stress in continents
- Stress Envelopes (Differential stress versus depth)

Example Problems

1. The Earth is a convecting fluid.

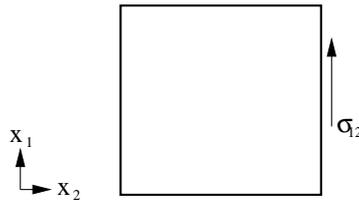
True False

2. Define an *incompressible fluid*. Explain your answer using your own words as well as an equation.

3. Define Fourier analysis .

4. A subducting slab rests above the 660 km discontinuity. Calculate how long it takes for this slab to thermally assimilate with the surrounding mantle. Assume thermal conductivity of peridotite ($k = 3.0 \text{ W m}^{-1} \text{ K}^{-1}$), density is 3250 kg/m^3 , and heat capacity is $C_p = 0.3 \text{ kJ kg}^{-1} \text{ K}^{-1}$ and a typical lithospheric slab thickness of 150 km.

5. In the diagram below, what does the 1 and 2 stand for in σ_{12} ? What does σ_{12} describe ?



6. Calculate deviatoric stress in continents assuming lithospheric thickness of 70 km, crustal density of 2800 g/cm^3 , and mantle density of 3300 g/cm^3 .

7. Draw a curve representing a) Newtonian material b) Non-Newtonian (power-law) material on the graph of stress versus strain rate below .

