Please find attached a list of review questions.

Think at them as
"what is/are...."
"how it works...."
"what is the basic physical principle...."
"what are the main applications...."
"which method is best suited for ....."

Regards
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Elastic media and elastic waves

- homogeneous/non homogeneous, isotropic/anisotropic medium

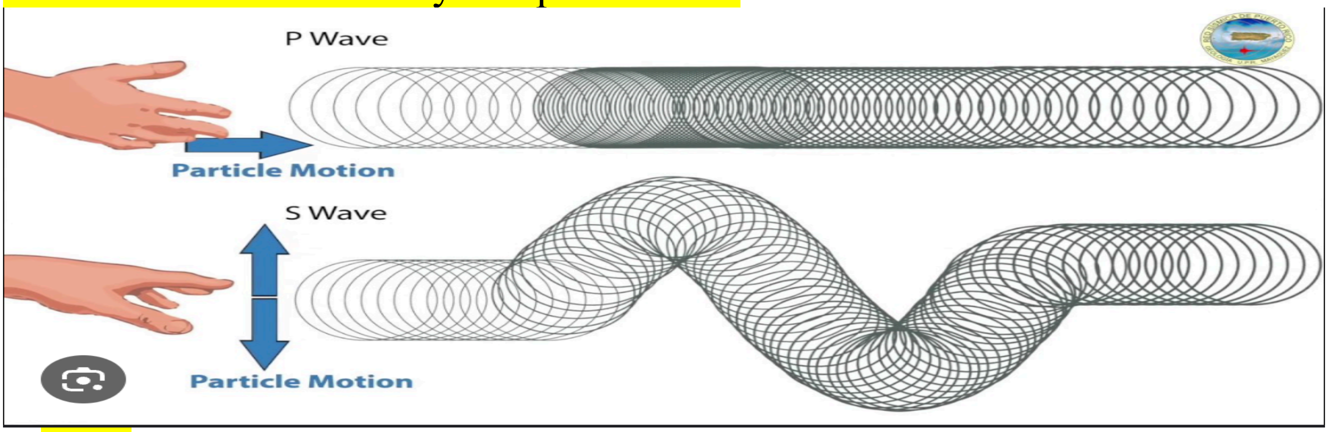
Homogeneous [ˌhɒməˈdʒiːniəs]: properties (e.g., density, elasticity) are the same everywhere. Example: Pure quartz.

Non-homogeneous [ˌnɒn həʊməˈdʒiːniəs]: properties change with position. Example: Sedimentary rock layers with different compositions.

Isotropic [aɪˈsɒtrəpɪk]: properties are the same in all directions. Waves travel at the same speed regardless of direction.

Anisotropic [ˌænɪˈsɒtrəpɪk]: properties depend on direction (e.g., layered or crystalline rocks). where wave velocity depends on the direction of propagation.

- P- and S-waves: velocity and polarization



P-waves: ongitudinal

- **P-waves** (primary, **compressional** [kəmˈpreʃənl]): particle motion is **parallel** to travel direction; go through **solids, liquids, gases**.
  Velocity: $V_p = \sqrt{\frac{K + \frac{4}{3}\mu}{\rho}}$ (bulk modulus K, shear modulus μ, density ρ).
- **S-waves** (secondary, **shear** [ʃɪə]): particle motion **perpendicular** to travel direction; **only in solids**.
  Velocity: $V_s = \sqrt{\frac{\mu}{\rho}}$.

Transverse or shear waves.

- surface waves
Travel **along the surface**; amplitude **decays with depth.**
Two main types:
Rayleigh [ˈreɪli] waves: elliptical motion (vertical + horizontal).
Love waves: horizontal shear motion; often largest amplitudes, slower than body waves.
Applications:
Used in seismic surveys and telecommunications for surface-based signal propagation studies.

- acoustic media
A medium in which pressure waves (P-waves) can propagate.
In fluids (liquids, gases) only compressional (P) waves propagate; no shear.
In solids, P and S waves both exist (elastic medium).
Applications:
Used in ultrasound, underwater acoustics, and telecommunications applications like SONAR and ultrasonic transducers.

- interface between 2 media: scatter coefficients,
- When a wave encounters a boundary between two materials, it undergoes **reflection, transmission, and refraction**.
- The **reflection coefficient R** and **transmission coefficient T** are calculated using:

$$R = \frac{z_2 - z_1}{z_2 + z_1}, T = 1 + R$$

- Used in radar, sonar, and medical imaging applications.

- wave amplitude attenuation. What causes wave amplitude attenuation?
Geometric spreading: energy spreads with distance
Intrinsic absorption: Energy is lost as heat due to the internal friction of the medium

(quantified by the quality factor Q).
Scattering: Part of the wave energy is deflected in different directions when encountering irregularities.

- measured variables, output display

Measured variables:
• Wave velocity, amplitude, frequency, phase, travel time.
• Output formats:
Seismic traces, wavefield snapshots, spectrum analysis graphs.
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Electrical methods √

- principles

Electrical methods — principles
We inject current into the ground and measure a voltage at the surface.
Using Ohm's law, we compute apparent resistivity $\rho_a = K \cdot \Delta V / I$ (K = geometric factor of the array). (Ohm's Law: $J = \sigma E$ where J is the current density, σ is conductivity, and E is the electric field.)
Current prefers low-resistivity paths; high-resistivity bodies deflect current.
The data are sensitive near the surface and less sensitive at depth (trapezoid coverage).

- equipment

Current electrodes (A, B), potential electrodes (M, N).
A resistivity meter (current source + voltmeter), electrode cables and switcher, GPS/measure tape.
In the homework: RES2DMOD (forward modeling) and RES2DINV (inversion) to simulate and invert data.

- how to build a pseudosection

•A pseudosection is a 2D representation of apparent resistivity.
Steps:
• Collect resistivity measurements using different electrode spacings.
• Arrange data in a depth plot, assuming greater depth for larger electrode spacing.

- apparent and true resistivity

Apparent resistivity (ρ_a) = what we compute directly from field data; it is an averaged response, not the true subsurface. a homogeneous medium.

True/model resistivity (ρ) = what we estimate by inversion (RES2DINV) from all the data, with regularization to stabilize the solution.

They use the same unit (Ω·m) but mean different things; do not compare values one-to-one.

- measured variables, output display

Measured: injected current (I) and voltage difference (ΔV).
Derived: apparent resistivity ρ_a, RMS misfit between measured and calculated data.
Displays (homework):
Measured pseudosection (observed ρ_a).
Calculated pseudosection (predicted ρ_a from the current model).
Inverse model resistivity section (estimated "true" ρ).
Sensitivity map (where data constrain the model best).
Keep the same color scale when comparing models; report RMS (%) to show data fit.

We inject current, measure voltage, compute $\rho_a = K\Delta V/I$, plot a pseudosection, and invert the data to get a resistivity model; ρ_a is data, ρ is the inverted model, both in Ω·m, and we judge quality with RMS and the sensitivity map.

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Electromagnetic methods √

- EM parameters
- low and high frequency measurements
- applications
- equipment (ground conductivity meter, metal detector)
- measured variables, output display

1. What are EM parameters?

• **Electrical conductivity (σ)**: Ability to conduct electricity. 电导率
• **Magnetic permeability (μ)**: Response to a magnetic field. 磁导率
• **Dielectric permittivity (ε)**: Response to an electric field. 介电率

2. What are low and high-frequency measurements?

• **Low frequency (e.g., magnetotellurics, VLF methods)**: Penetrates deeper.
• **High frequency (e.g., Ground Conductivity Meters, GPR)**: Limited penetration, higher resolution.

3. What are the applications?

• Used in geophysical exploration, detecting underground utilities, and environmental assessments.

4. What equipment is used?

• **Ground conductivity meter**: Measures conductivity to map subsurface variations.
• **Metal detector**: Finds buried metallic objects based on induced eddy currents.

5. What are the measured variables and output display?

• **Variables**: Magnetic field strength, phase shift, conductivity.
• **Output**: Conductivity-depth profiles, subsurface maps.

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-GPR √

- principles
- applications
- link between antenna central frequency, penetration depth, resolution
- measured variables, output display

1. What are the principles?

• GPR transmits high-frequency electromagnetic waves into the ground.
• Reflections occur at material boundaries with different dielectric permittivity.

2. What are the applications?

• Used for utility detection, archaeological surveys, structural assessment, and environmental studies.

3. What is the link between antenna frequency, penetration depth, and resolution?

• Higher frequency:
Better resolution, but lower penetration.
Used for detecting shallow objects (e.g., cables, concrete assessment).
• Lower frequency:
Greater penetration, but lower resolution.
Used for deeper targets (e.g., groundwater, void detection).

4. What are the measured variables and output display?

• Variables: Reflection amplitude, two-way travel time, depth.
• Output: Radargrams (amplitude vs. travel time), depth slices, 3D subsurface models.