I Q.1

In digital images, grayscale means that the value of each pixel represents only the intensity information of the received wave. For instance, X-Rays grayscale value represents the X-ray beam attenuation to the tissue. Pixels with value close to 0 (darker pixels) represent structures having less attenuation to the beam, i.e., soft tissue, while pixels close to 255 (light pixels) represent structures having high attenuation, i.e., calcifications. Here are examples of different imaging modalities:

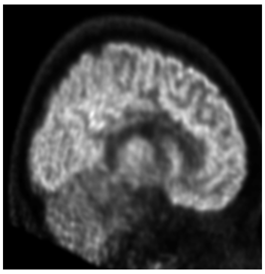

Figure 1: PET image of a brain

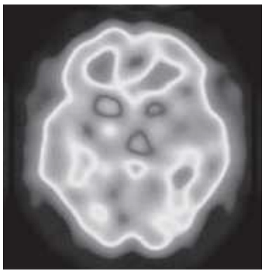

Figure 2: SPECT image of a brain

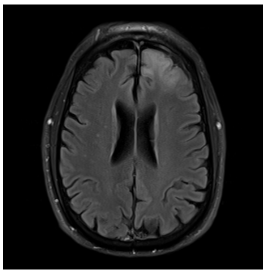

Figure 3: MRI image of a brain

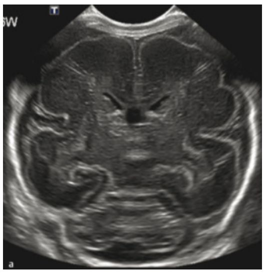

Figure 4: US image of a brain

Figure 5: CT image of a brain

Figure 6: X-Ray image of a brain (Head)

Imaging Modality	Main Source	Detects
PET	Annihilation Photons	Intensity of Annihilation Photons
SPECT	Gamma Rays	Intensity Gamma Rays
MRI	Electric & Magnetic Fields and Radiowaves	Intensity of Radiowaves
US	Sound Waves	Acoustic Intensity
CT	X-Rays	Attenuated X-Rays
X-Ray	X-Rays	Attenuated X-Rays

II Q.2

A Faraday cage creates a barrier between the internal components of a device and the external electric fields. It works because an outside electric field causes a redistribution of the electric charges within the enclosure's conducting material, which in turn cancels the field's effect in the cage's interior. In MR imaging, this type of structure provides radiofrequency shielding to the scanning room to minimize occurrence of interference-associated imaging artifact.

III Q.3

Knowing the skin depth of the material, which equals to $\delta = \sqrt{\frac{\rho}{\pi f \mu}}$ is a the key to shielding by Faraday's cage. We need to find a conductor with low resistivity to obtain a small skin depth, then we need to to shield using a thickness significantly higher than the skid depth.

III.I Example:

If we want to shield using copper ($\rho = 1.72 \times 10^{-8}\Omega m$), from an RF radiations, with at least $f = 20kHz$, then:

$$\begin{aligned} \text{Skin Depth} = \delta =& \sqrt{\frac{\rho}{\pi f \mu}} \\ =& \sqrt{\frac{1.72 \times 10^{-8}}{\pi \times 20 \times 10^3 \times \mu_0}} \\ =& 0.467mm \end{aligned}$$

This means we must have a shield made out of copper with thicknesses higher in orders of magnitudes than 0.467mm, like $5mm$ or $5cm$ of copper will be sufficient. If we want to shield for the same radiation using Iron ($\rho = 9.71 \times 10^{-8}\Omega m$), then:

$$\begin{aligned} \text{Skin Depth} = \delta =& \sqrt{\frac{\rho}{\pi f \mu}} \\ =& \sqrt{\frac{9.71 \times 10^{-8}}{\pi \times 20 \times 10^3 \times \mu_0}} \\ =& 1.1mm \end{aligned}$$

This means we must have iron shield with thicknesses like $15mm$ or $15cm$.

IV Q.4

You can easily check for faraday leakage by sitting inside a room with a receiver and ask someone outside to send RF signals with different freqencies inside the RF region, then switching the roles. If nothing is detected then the Faraday's cage is working fine.

V Q.5

The slab took more time to hit the ground in the 3.0T MRI than it took in the 1.5T. This is because there was a force acting on the slab that is directly proportional to the magnetic field, and it is called Lorentz force and described by:

$$F = q\vec{v} \times \vec{B}$$