

MRI (MAGNETIC RESONANCE IMAGING):-

- MRI (Magnetic Resonance Imaging) also known as Nuclear Magnetic Resonance Imaging (NMRI), since it works on the principle of Nuclear Magnetic Resonance.
- It is a medical imaging technique used in radiology to take pictures of the anatomy and the physiological processes of the body.
- This technique uses a very powerful magnet to align the nuclei of the atoms inside the body, and a variable magnetic field that causes atoms to resonate (a phenomenon called Nuclear Magnetic Resonance or NMR). The nuclei produce their own rotating magnetic fields that a scanner detects and creates an image.

Working Principle of MRI:-

- The basis of MRI is nuclear magnetic resonance. Nuclei that contain odd no. of protons and/or neutrons will have a characteristic motion or precession, which produces a small magnetic field.
- When a human body is placed in a strong uniform magnetic field of 10.5 to 1.5 Tesla, many of the free Hydrogen

nuclei align themselves with the direction of the magnetic field, the phenomenon is called Larmor precession and the frequency of Larmor precession is called Larmor frequency.

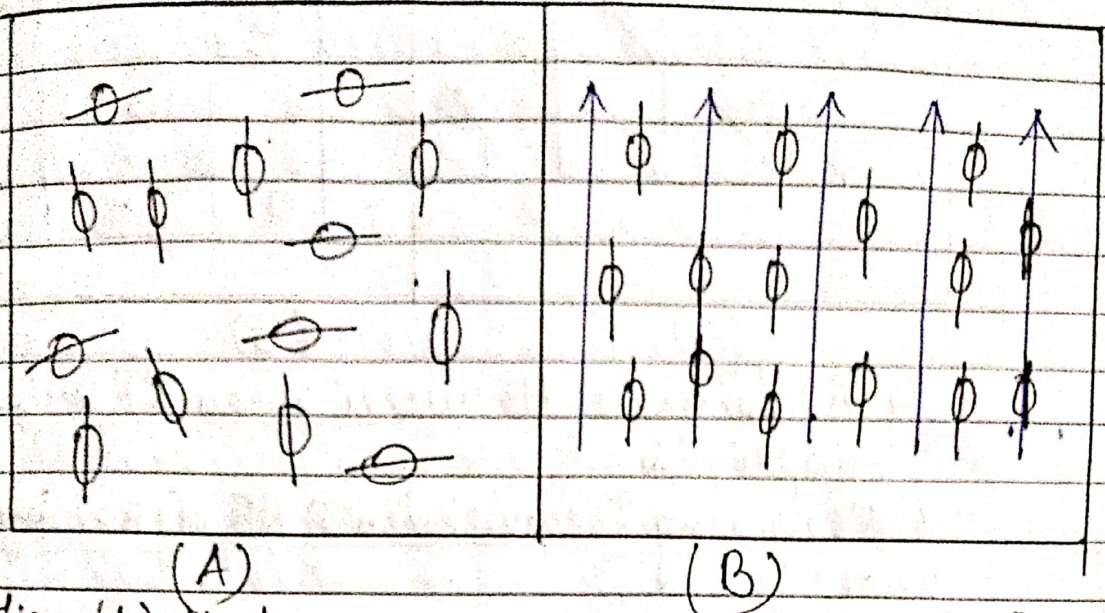
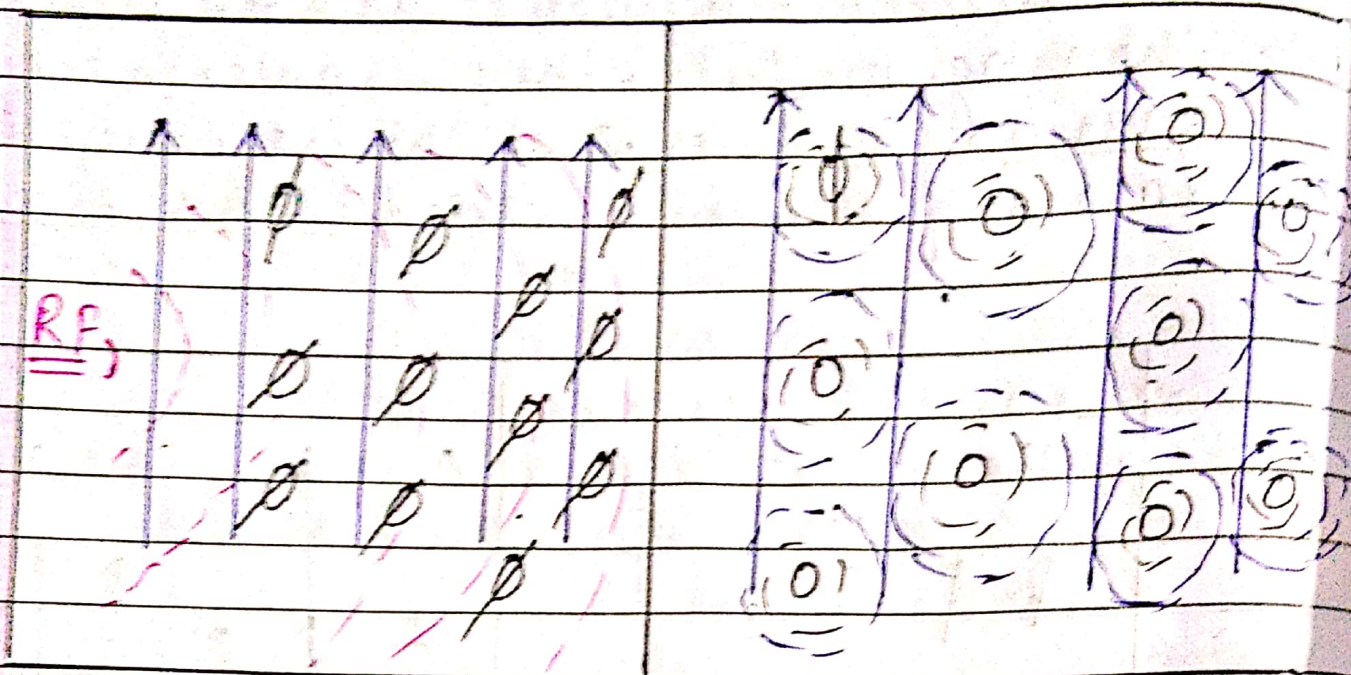


Fig:- (A) Hydrogen nuclei randomly aligned in absence of magnetic field.

(B) H-nuclei precess along the direction of magnetic field.

→ Now, a Radio-frequency (RF) pulse is applied perpendicular to the magnetic field. The RF pulse with a frequency equal to Larmor frequency, causes the nuclei to tilt away from the magnetic field.

→ Once the RF pulse is stopped, the nuclei regain themselves or return back to their original position. During this relaxation the nuclei lose energy by emitting their own RF signal which is called Free Induction decay (FID) resonance signal.



(A)

(B)

Fig (A) Tilting of H-nuclei when RF pulse is applied.

(B) Regaining & emission of RF signal by H-nuclei.

*** Instrumentation

** Instrumentation -

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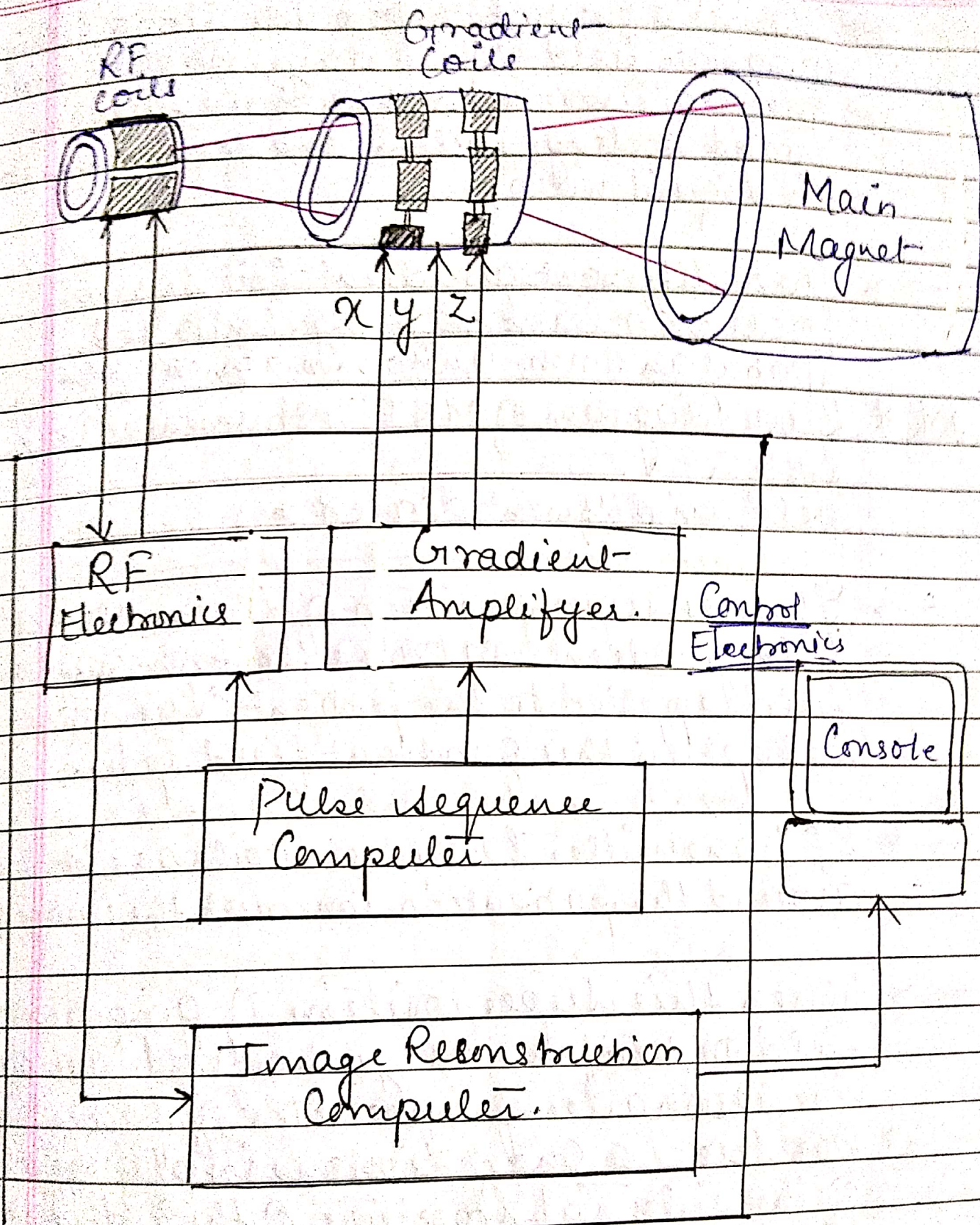
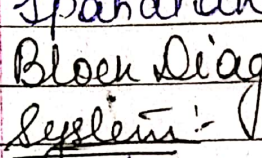


Fig 6 - MRI Scanner Components :-

→ There is a magnet to provide strong & uniform magnetic field. Now a days, superconducting magnets are used in which have helium liquid cooling system and are immersed in liquid nitrogen.

→ Three different gradient-coil systems produce a time varying, controlled, spatial and non-uniform magnetic field.

*** Block Diagram of MRI Instrumentation Systems: 
field in different direction.

→ There is super-position of linear magnetic field gradient on to the uniform magnetic field applied to the patient. The patient is kept in this gradient field space.

→ RF transmitter & receiver coils are placed around the patient to construct the image.

→ When this super-position of gradient field on uniform magnetic field takes place the resonance frequencies of precession produces a one-dimensional projection of the internal structure of the 3-dimensional object.

→ From the projections at different gradient orientations using x, y and z-gradient coils, a two- or three dimensional image can be obtained.

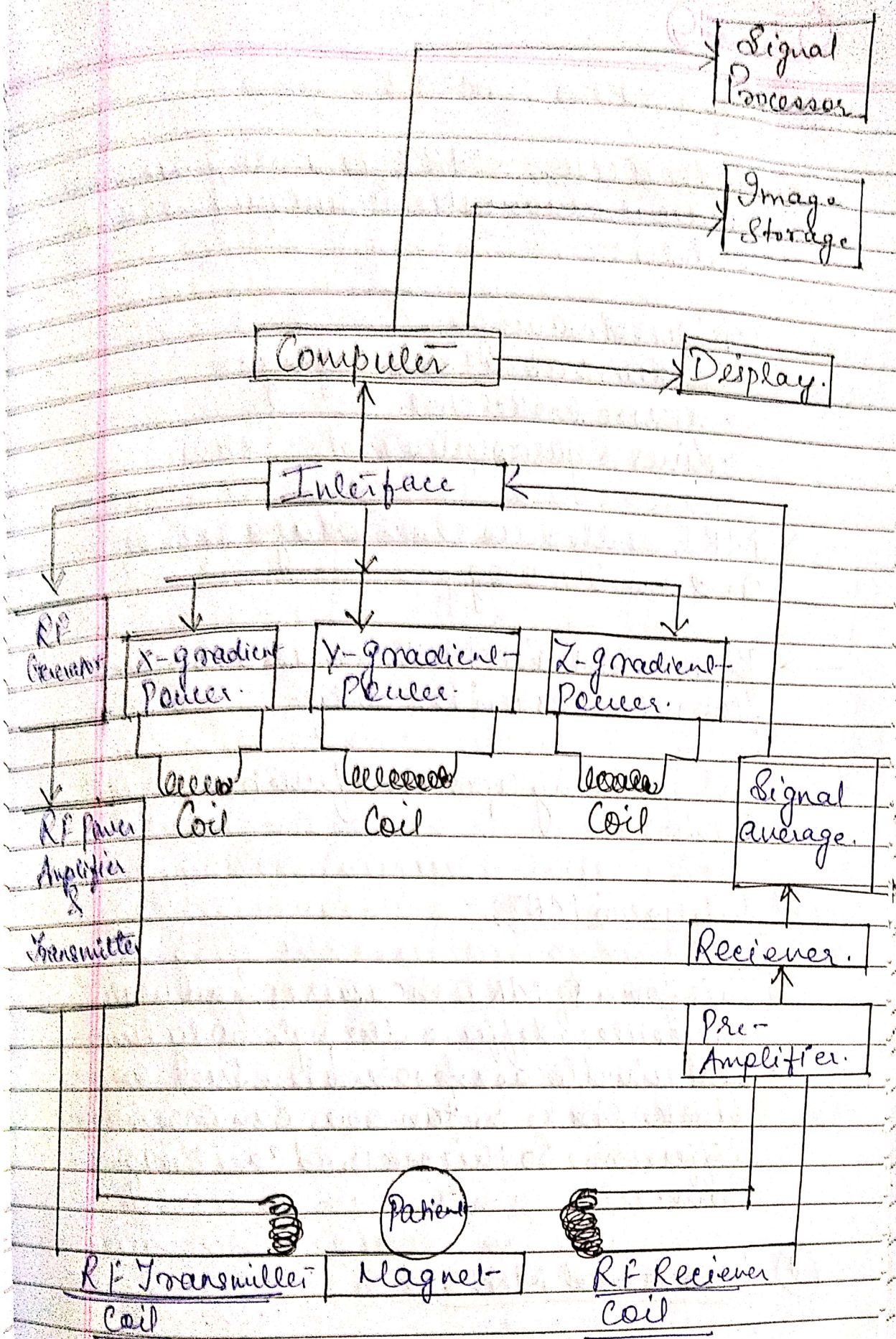


Fig:- Block Diagram of MRI Instrumentation System.

* Applications of MRI :-

→ Medical Uses :- MRI is a very accurate medical diagnostic technique which is used in :-

→ Neuroimaging.

→ Cardio-vascular imaging.

→ Musculoskeletal.

→ Liver & gastrointestinal etc.

→ MRI is also used in diagnosis of tumours and in Oncology.

→ Phase-Contrast-MRI is used to measure flow velocities in the body.

Depending upon the functions of MRI can be :-

(i) Diffusion MRI :-

This form of MRI measures how water molecules diffuse through body tissues. Certain disease processes such as ~~stroke~~ stroke or tumours can resist this diffusion, so this method can diagnose them.

(ii) Functional MRI :-

In addition to structural imaging, MRI can also be used to visualize functional activity in the brain. Functional MRI measures changes in blood flow to different parts of brain.