



Summer– 15 EXAMINATION

Subject Code: **17673**

Model Answer

Page No: 1/ 30

Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.



Summer– 15 EXAMINATION

Subject Code: 17673

Model Answer

Page No: 2/ 30

Q.1 (a) Attempt any THREE of the following:

Mark12

i) State the working principle of nuclear imaging.

4m

(Working principle 4m)

Ans:

working principle of nuclear imaging:

It is a branch of medical imaging which deals with the application of radioisotopes for the assessment of functional status of biological organs and subsystem.

In this type of imaging diagnosis is based on the evaluation of images of the organ obtained by a various devices such as rectilinear scanner, gamma camera and tomography systems like PET etc.. These images are referred to as medical images and are result of radio activity distribution in the organs or body site.

This is done by administration of radioactive isotope inside the body and then detecting its distribution.

Stepwise procedure of nuclear imaging:

1. Radionuclide is administered via mouth or vein.
2. They distribute in the body according to their strength for particular tissue called target tissue.
3. Radionuclide emit gamma radiation
4. Theses radiations are detected by a gamma camera, which forms the image showing the location of radionuclide in the body.

ii) Prepare a list of any four steps to be carried out for maintenance of ultrasound machine.

4m

(Each step 1 mark)

Ans:

Maintenance of ultrasound machine:

1. Wipe dust off exterior & cover equipment after check.
2. Remove any tape, paper or foreign body from equipment.
3. Wipe probe with alcohol free tissue or cloth.
4. Check all fittings & accessories are mounted correctly.
5. Check cables are not twisted & probe is safely stored.
6. Unplug, clean outside /wheels/rear with damp cloth, dry off.

7. Remove, clean & dry external filter if present.
8. Check mains plug screws are tight or not.
9. Check mains cable has no bare wire & is not damaged.
10. If machine has not been in use, run & test it periodically. Every six months Biomedical Technician check machine.

iii) Draw a neat labeled block diagram and state the function of each block of MRI detection system. 4m

(Diagram 2m + Function 2m)

Ans:

Block diagram of MRI detection system:

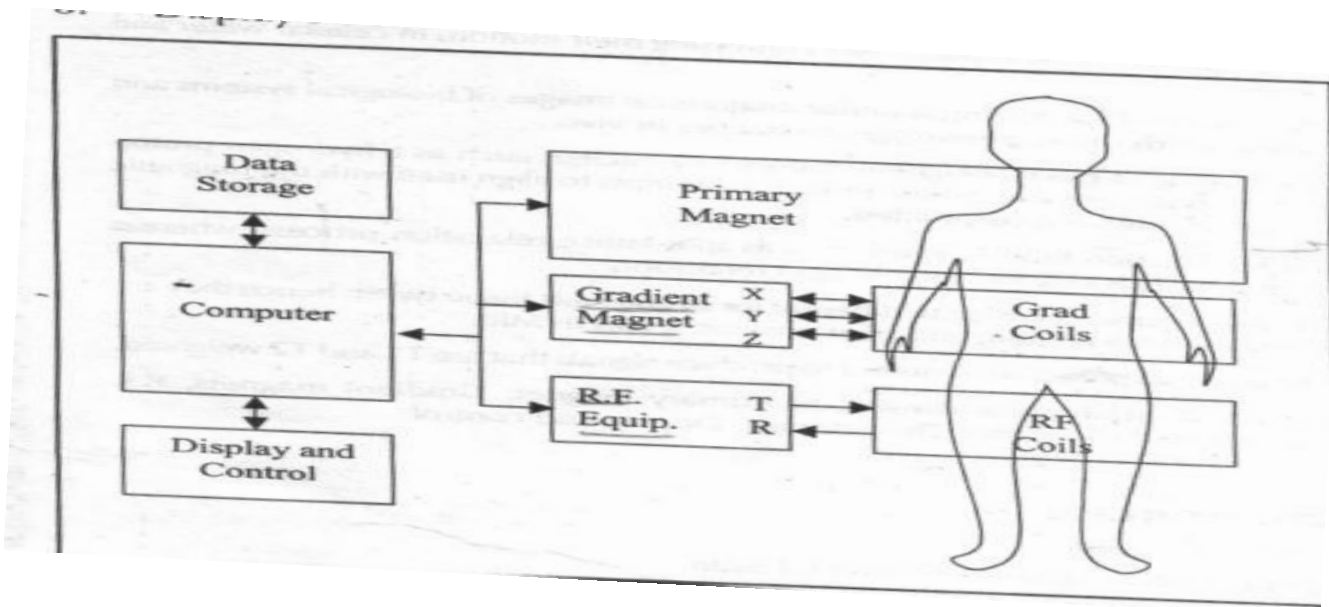


Fig: Block diagram of MRI detection system

Function of each block of MRI detection system:

It consists of primary magnet, gradient magnet, RF equipment, computer, data storage, display and control. The primary magnet consists of either a resistive, superconductive or permanent magnet that provides a uniform magnetic field around the patient.

Gradient magnet system consists of auxiliary sets of x, y and z gradient magnet coils. These coils are driven by high power audio amplifier that rapidly turn on and turn off to provide signal localization. RF equipment consists of transmitter capable of applying RF pulses in narrow frequency band. The system computer controls all these devices as well as performs the FFT necessary for assigning x, y, z coordinates. The data is stored as numbers array that is displayed under computer control as a video image on the display system.

iv) With neat labeled diagram state working principle of endoscopy.

4m

(Diagram 2m + Working 2m)

Ans:

Diagram of endoscopy:

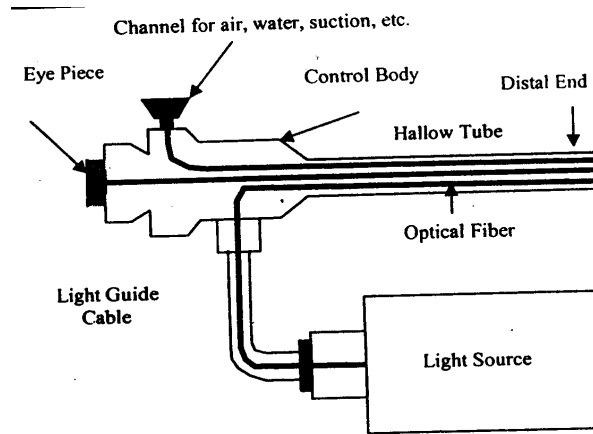


Fig : Diagram of endoscopy

Working principle of endoscopy:

The construction of endoscope is shown in fig.

It consist of following components:

1. Hollow tube
2. Light source
3. Optical fiber
4. Eye piece
5. Channel for air, water, biopsy and suction.

Endoscope is tube which can enter the body through its natural opening. this tube has suitable and diameter to match natural openings .

An optical fiber inside the tube carries light from the light source to illuminate the area in front of its distal tip end. A reflected light from the distal tip that is image is transferred through another optical fiber to eyepiece for viewing.

The control mechanism provides control over the channels of air water, biopsy and suction.

Q.1 (b) Attempt any ONE of the following :

Marks 06

i) State the significance of angiography. Draw the block diagram of angiography system and write the function of each block.

6m

(Significance 2m + Diagram 2m + function of each block 2m)

Ans:

Significance of angiography:

It is a diagnostic & therapeutic procedure which is related to the disease of circulatory system. This procedure is carried out by using or by inserting contrast material called as radioisotopes mostly iodine containing compound which is radioactive in nature is used.

The contrast material provides radiographic image which is viewed on TV screen they are recorded as a film or video. It is a invasive method that helps the physician to diagnose & treat the medical condition.

Block diagram of angiography:

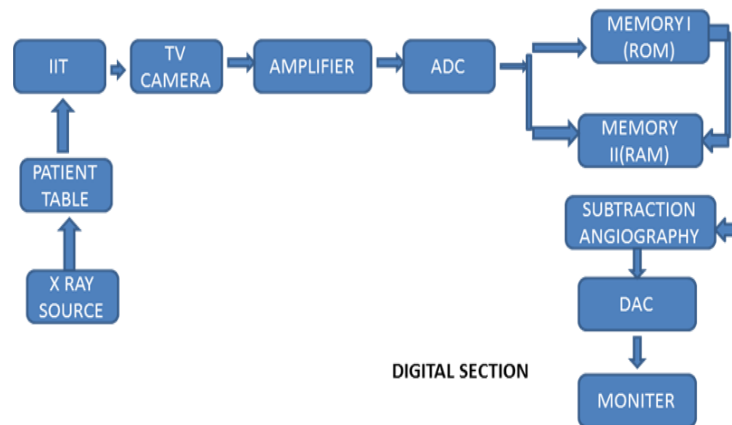


Fig: Block diagram of angiography

Function of each block:

1. **X ray source:** It is used to pass narrow x ray beam to the patient.
2. **Patient table:** patient is lie on table.
3. **IIT:** The reflected x rays are collected by IIT unit in which brightness of image is increased & output is displayed on fluorescent screen.
4. **Amplifier:** It amplifies the output of image intensifier tube and gives it to the ADC where signal is converted into digital form.
5. **Memory I & II :** digitally converted signal is stored into the ram & rom memory.
6. **Subtraction angiography:** to get a new image subtraction angiography is used to the analog signal on the monitor for which DAC is used.
7. **DAC:** it converts digital signal into analog signal.
8. **Monitor:** by using TV camera unit +we can see the clear *& live image of an patient body on monitor.

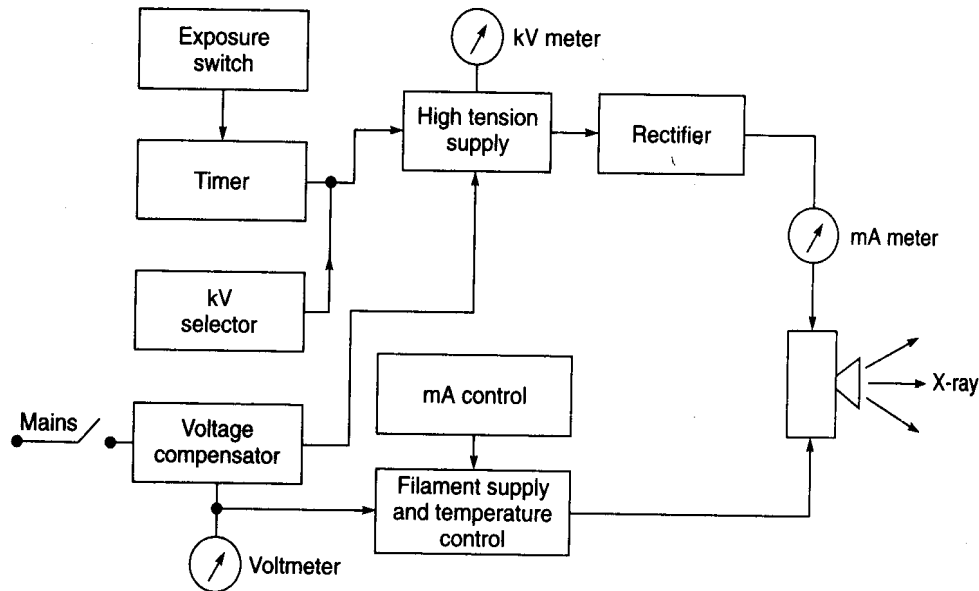
ii) Draw block diagram of X-ray machine and state the function of each block.

6m

(Diagram 3m + Function 3m)

Ans:

Block diagram of X-ray machine:



► Fig. 19.5 Block diagram of an X-ray machine

Function of each block:

There are two parts of the circuit one of them producing high voltage which is applied to the tubes anode and cathode and consist of high voltage step up transformer flowed by a rectification. The current through the tube follows the HT pathway and is measured by mA meter. A Kv selector switches are used a change in voltage exposure. The voltage is measured by Kv meter. Exposure switch controls the timer and thus the duration of the application of Kv.to compensate for mains supply voltage variation voltage compensator is used. Second part is x ray filament .it is heated with 6-12V OF ac supply. the filament determines the tube current which is controlled by using primary side of the filament transformer.

Q.2 Attempt any **FOUR** of the following:

Marks 16

a) Enlist the techniques of image reconstruction and write any one technique with neat diagram. 4m

(List techniques 1m +Any one technique Diagram 2m+ Working of any one technique 1m)

Ans:

Enlist the techniques of image reconstruction:

Various image reconstruction techniques used in CT are

1. Back projection reconstruction technique.
2. Filtered back projection technique.

3. Iterative reconstruction technique.

4. Fourier reconstruction technique

Working of image reconstruction technique (any one consider)

1. Back projection reconstruction technique:

Diagram of Back projection reconstruction technique:

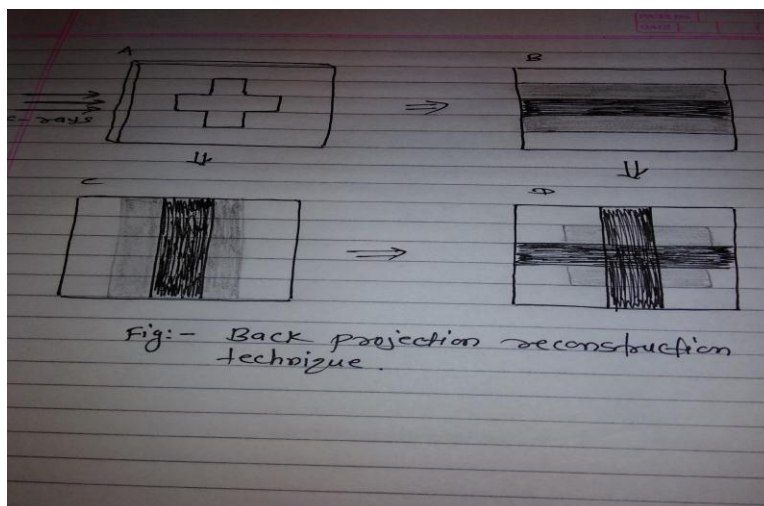


Fig: Back projection reconstruction technique

Working of Back projection reconstruction technique:

Back projection some times called the 'summation method' which demonstrates a two dimensional reconstruction of a cross cut from the center of a solid block. The block is scanned from both the top & left sides by a moving X-ray beam to produce the image profile shown in fig. the image profile look like steps. The height of the steps is proportional to the amount of radiation passed through the block. The center transmitted the most radiation, so it is the highest step in the image profile. The steps are then assigned to a gray scale density. That is proportional to their height. These densities are arranged in rows, called 'Rays'. The width of the rays is the same as the width of the steps in the profile. The ray length is equal to the height of the original object. In back projection produce a crude reproduction of the original object.

2. Filtered back projection technique:

Diagram of filtered back projection technique:

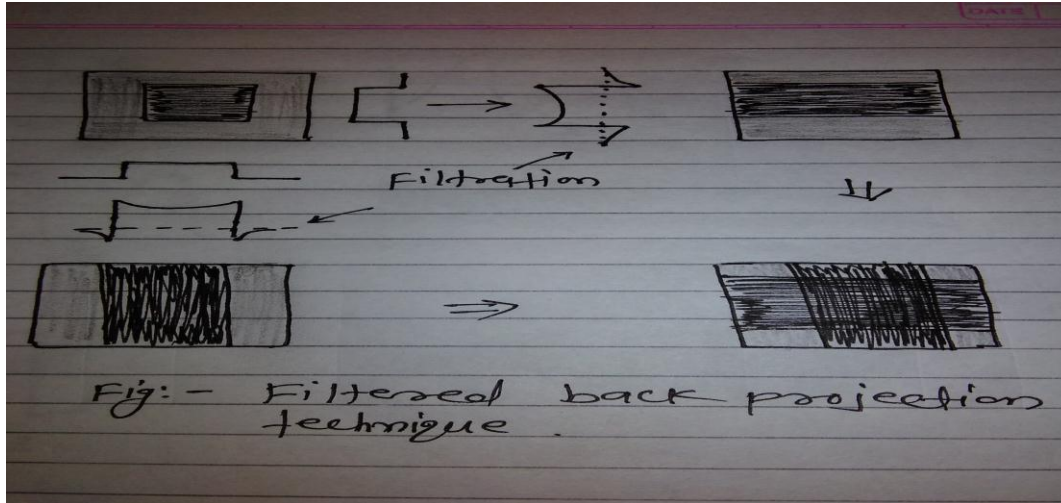


Fig: Filtered back projection technique

Working of filtered back projection technique:

Filtered back projection is similar to back projection expect the image is filtered or modified to exactly counterbalance the effect of sudden density changes , which causes blurring (the star pattern) in simple back projection. In this technique the projected information is filtered much like light is filtered by a polarizing lens. The fig shows a two dimensional filtered back projection of a square object. The density of the projected rays is adjusted to compensate for the star effect.

3. Iterative reconstruction technique:

Working of Iterative reconstruction technique:

In the iterative reconstruction for a four element square .Horizontal ,vertical , & diagonal ray sums are shown in the adjacent blocks . In the first step , the two horizontal ray sums (16 &6 in the hatched blocks) are divided equally among the two element in the ray. If the ray sums had represented 10 elements , the sum would have been divided equally among all 10 elements. Next the new numbers in the vertical row are added to produce the new ray sum (11 &11 in the shaded blocks) and compared with the original measured ray sums ((also in shaded blocks). The difference between the original & new ray sums (10-11= -1 and 12-11= +1) is divided by the number of elements in the ray (-1/2 = -0.5 and +1/ 2 = +0.5).These differences are algebraically added to each element (8-0.5 =7.5 , 3-0.5 =2.5 , 8+ 0.5 = 8.5 , and 3+ 0.5 = 3.5) The process is repeated for diagonal ray sums to complete the first iteration.

Diagram of Iterative reconstruction technique:

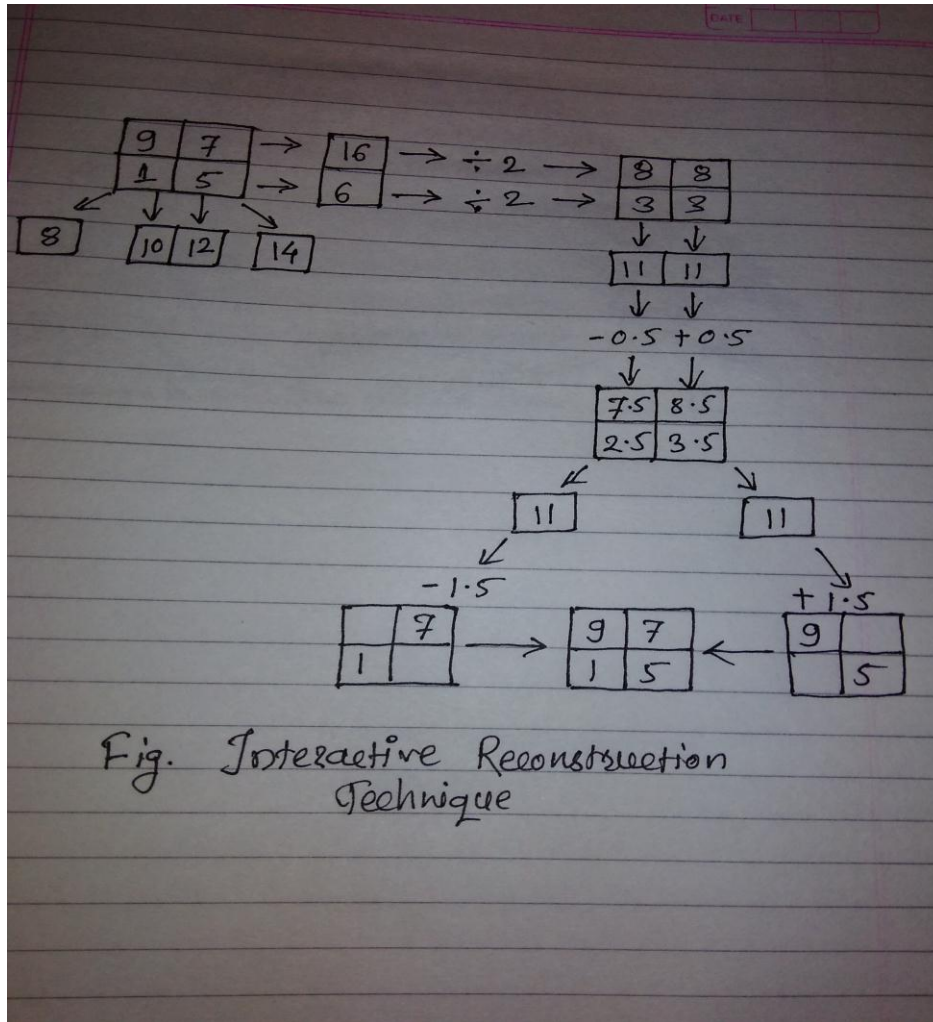


Fig: Iterative reconstruction technique

Working of Iterative reconstruction technique:

In the iterative reconstruction for a four element square . Horizontal ,vertical , & diagonal ray sums are shown in the adjacent blocks . In the first step , the two horizontal ray sums (16 &6 in the hatched blocks) are divided equally among the two element in the ray. If the ray sums had represented 10 elements , the sum would have been divided equally among all 10 elements. Next the new numbers in the vertical row are added to produce the new ray sum (11 &11 in the shaded blocks) and compared with the original measured ray sums ((also in shaded blocks). The difference between the original & new ray sums ($10 - 11 = -1$ and $12 - 11 = +1$) is divided by the number of elements in the ray ($-1/2 = -0.5$ and $+1/2 = +0.5$). These differences are algebraically added to each element ($8 - 0.5 = 7.5$, $3 - 0.5 = 2.5$, $8 + 0.5 = 8.5$, and $3 + 0.5 = 3.5$) The process is repeated for diagonal ray sums to complete the first iteration.

4. Fourier reconstruction technique

Diagram of Fourier reconstruction technique :

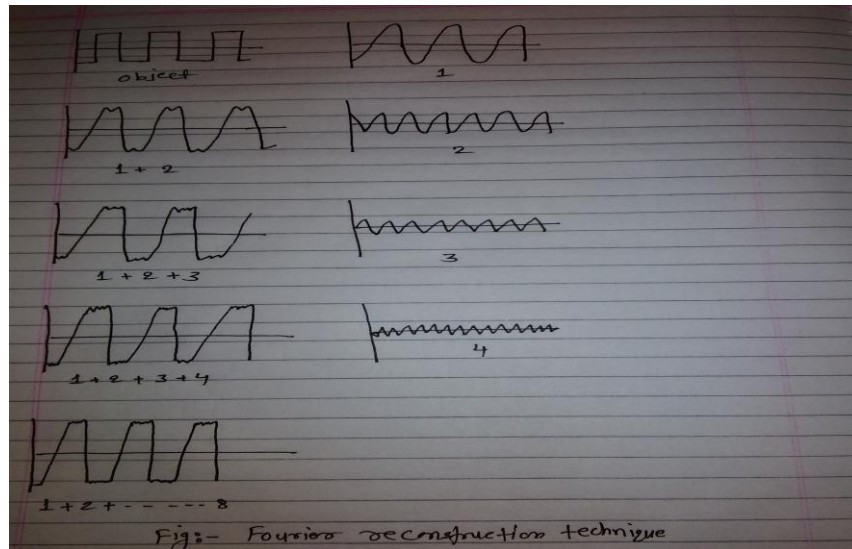


Fig: Fourier reconstruction technique

Working of Fourier reconstruction technique :

The basis of Fourier analysis is that any function of time or space can be represented by the sum of various frequencies and amplitudes of sine and cosine waves. The ray projections are shown with squared edges, which is the most difficult wave form to reproduce. The actual projected images would be more rounded than those shown, which would simplify a Fourier reconstruction. The last reconstruction represents the sum of eight cosine waves, but only the first four steps are shown in fig. This type of mathematical manipulation is easily and quickly processed in a computer.

b) Write any four properties of ultrasound.

4m

(Each property 1m)

Ans:

Properties of ultrasound:

1. Ultrasounds frequency are the audible level, that is at frequencies above 20 kHz.
2. Ultrasound travels at velocity of about 1500m/s in soft tissue of the body.
3. The velocity of ultrasound waves in various biological media is approx. the same and nearly equal to that in water.
4. Velocity in bone about 3 times higher and in air it is 3 times less.

c) Explain transducers used in nuclear medical imaging.

4m

(Each transducer 1m)

Ans:

Transducers used in nuclear medical imaging:

1. Geiger Muller tube detector
2. scintillation counter / detector
3. semiconductor detector
4. xenon gas detector

d) Sketch symbols , label , terminals , and sketch V-I characteristics of SCR and DIAC.

4m

(Symbols 1m + Label Terminals 1m + V-I characteristics 2m)

Ans:

Symbols, label , terminals , and sketch V-I characteristics of SCR and DIAC:

Symbol	VI characteristic
<div style="text-align: center;"> </div> <p style="text-align: center;">SCR</p>	

DIAC

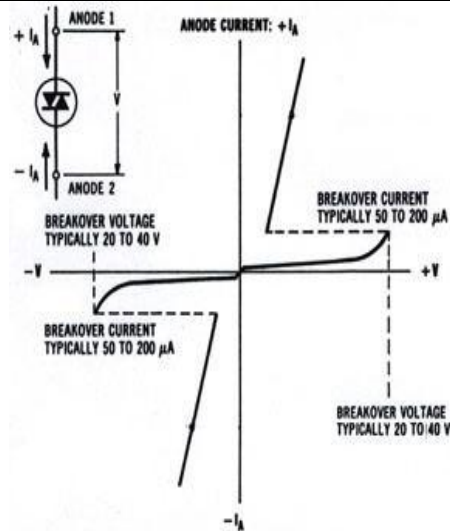
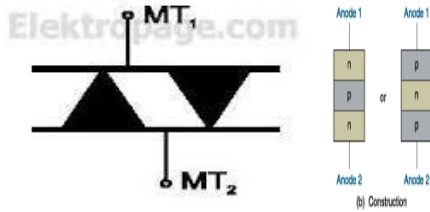


Fig : symbols, label terminal and sketch V- I characteristics of SCR and DIAC.

e) Define the term maintenance and state three steps carried out in maintenance of angiography machine . (Definition 1m+Three steps 3m)

4m

Ans :

Definition of maintenance:

Maintenance:

It is defined as procedures which are used to minimize the risk of failure and to ensure continuous proper operation of equipment.

Maintenance of angiography machine:

1. Maintenance must be performed in the normal mode.
2. Check Program: Check Program must be performed in the normal mode.
3. Perform calibration and maintenance with a personal computer, it is necessary to
4. Prepare the following:
5. Personal computer where the Windows 95 / 98 has been installed.
6. Adjust the DC power of the board surely because it is used as a reference voltage for A/D conversion.
This adjustment should be made with all the units connected, including the Display Unit, console, and options.
7. Check calibration for motor of arm
8. Check calibration of position table for its up down movement.
9. Check collimator alignment and its position
- 10 Check x ray tube alignment & its position.
- 11 Check shutter & filter calibration.
12. Check battery & maintain cover.
13. Update software periodically.
14. Check TV camera connections , IIT, XRAY TUBE

f) State the steps carried out in installation of MRI machine.

4m

(Each step 1m)

Ans:

Steps carried out in installation of MRI machine:

1. Prepare site planning.
2. Understand the RF shielding and magnetic shielding requirement.
3. Pay attention to exterior features. For example, moving metals, whether from a nearby garage or traffic outside the building are limiting factors. Overhead power lines or underground power can be challenging, as can running water or sewer lines above and below the magnet.
4. Consider Patient safety is key.
5. Floor area of MRI room must be even.
6. Unpack the shipment of MRI panels and organize them for easy access
7. Unpack and assemble
8. Set up a laser level in one corner of the room being covered and adjust it so it will show the desired elevation for the top of the MRI panels to be installed.
9. Install all the MRI PANELS ONE BY ONE
10. Once all the MRI PANELS installation is done, check the connection in console room
11. Perform a demo test to check the performance of machine.

Q.3 Attempt any FOUR of the following :

Marks 16

a) With neat labeled diagram explain working of ultrasonic transducer.

4m

(Diagram 2m + working 2m)

Ans :

Diagram of ultrasonic transducer :

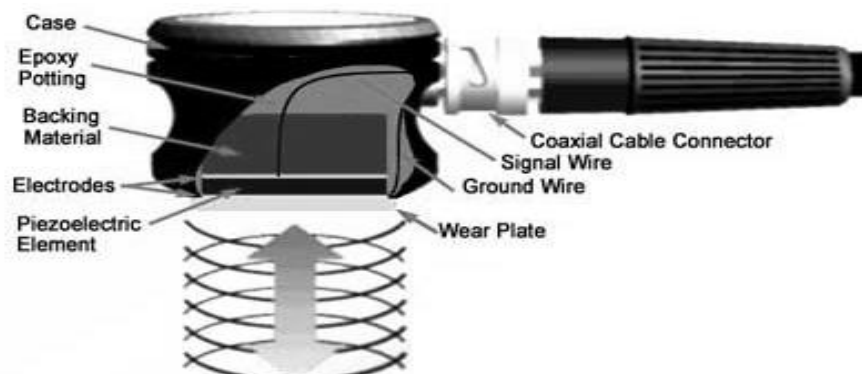


Fig: Diagram of ultrasonic transducer

Working of ultrasonic transducer:

The transducer is a device that can convert one form of energy into another. Ultrasonic transducers are used to convert an electric signal into ultrasonic energy that can be transmitted into the tissues, and to convert ultrasonic energy reflected back from the tissue into electrical signal.

The most important component in ultrasonic transducer is piezoelectric crystal. Piezoelectric materials are made up of numerous dipoles arranged in geometric pattern shown in fig a below. An electric dipole is a distorted molecule that appears to have a positive charge on one end and negative charge on the other. The positive and negative ends are arranged so that the electrical field will cause them to realign, thus changing the dimensions of crystal shown below in the fig b. The plating electrodes behave as capacitors. If a voltage is applied in a sudden burst, or pulse, the crystal vibrates and generates sound waves. As the sound pulses pass through the body, echoes reflect back towards the transducer from each tissue interface. These echoes carry energy and they transmit their energy to the transducer, causing a physical compression of the crystal element. This compression forces the tiny dipoles to change their orientation, which induces a voltage between the electrodes. The voltage is amplified and serves as the ultrasonic signal for display on an oscilloscope or television monitor.

b) Draw neat labeled diagram and state working of thermography machine. 4m

(Diagram 2m + Working 2m)

Ans:

Diagram of Thermography machine:

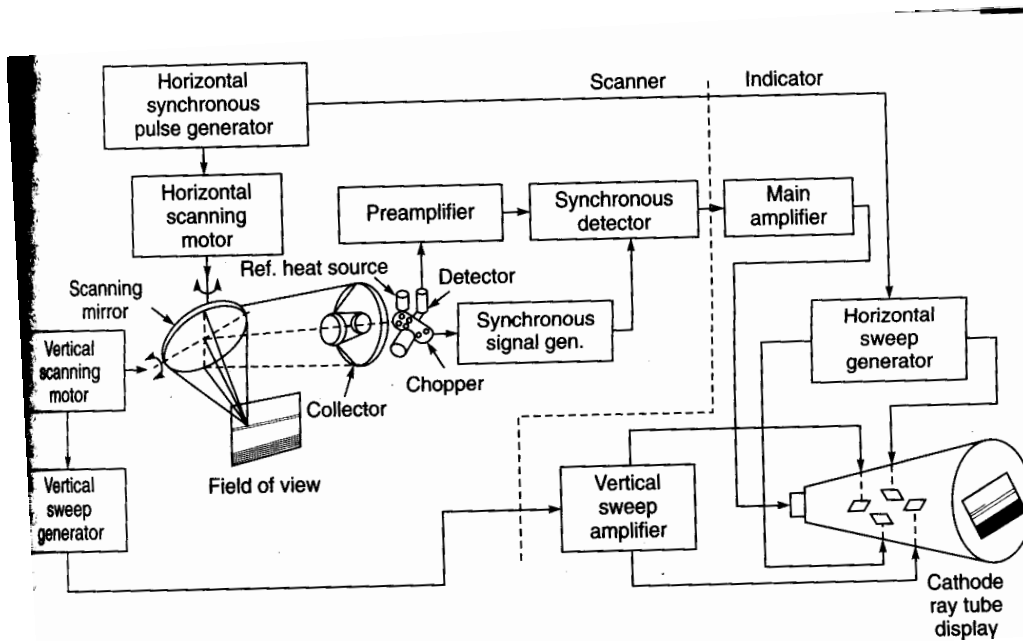


Fig: Diagram of Thermography machine

Working of Thermography machine:

It consist of two units :

1. A special infrared camera that scans the object
2. Display unit



Camera is generally mounted on a tripod that is fitted on wheels.

Camera unit contains an optical system which scans the field of view at a very high speed and focuses the infrared radiation on detector that converts the radiation signal into electrical signal. The signal from camera is amplified and processed before being used to modulate the intensity of the beam in the picture tube.

The beam sweep across the the tube face in a pattern corresponding to the scanning pattern of the camera. The picture on the screen can be adjusted for contrast and brightness by means of controls on display unit.

The double scanning movement of the plane mirror causes each spot on the patient body to be focused in turn on the cooled detector. The detector is mounted in a Dewar flask which also eliminates thermal noise.

The horizontal and vertical movements of the scanning mirror are controlled by individual motors. Scanning of flat mirrors generates horizontal synchronous pulses and vertical sweep signals for the display unit.

A chopper disc interrupts light from a std. heat source which intermittently illuminates a photocell and provides a phase reference to a coherent detector and to a bucking circuit employed to cancel out large standing signals.

The AC signal developed by the by the detector is amplified by the preamplifier. It is then rectified and fed to band pass filter where chopping frequency is determined, and signals are displayed on CRT tube.

c) Write the process of conversion of X-Ray quanta into a Bright output image with the help of diagram of image intensifier tube.

4m

(Diagram 2m+ process 2m)

Ans:

The process of conversion of X-Ray quanta into a Bright output image:

Image intensifier is use to produce an image bright enough for normal vision and small enough to be coupled to cine, television or spot film camera.

Image intensifier tube consists of

1. Input phosphor or photo cathode
2. Electrostatic lens
3. Accelerating anode
4. Output phosphor

The image intensifier tube is placed between the patient and fluoroscopy screen. The input fluorescent screen absorbs the X-ray photons. The X-ray photons then interact with the phosphor giving up energy to the outer orbit electrons of phosphor atom. Due to this additional energy atoms gets excited. Excited atoms further gives up the surplus energy as visible light photons. These light photons strikes the photo-cathode causing it to emit photoelectrons. Then these electrons get immediately accelerated towards the anode due to high positive potential applied to the anode with respect to cathode. As the electrons flow toward the anode, they are focused by an electrostatic lens to the output fluorescent screen. The electrons strike this florescent screen that emits the light which carry the fluoroscopic image to the observer.

Diagram of image intensifier tube:

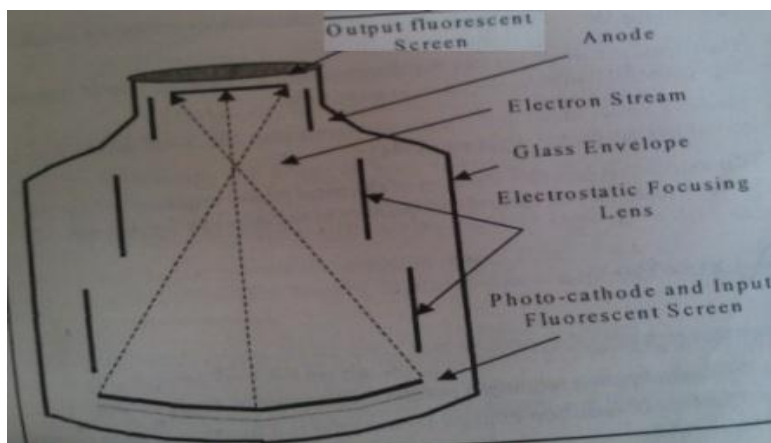


Fig: image intensifier tube

d) Write stepwise maintenance procedure for X-Ray machine.

4m

(Each step-1m)

Ans:

Maintenance procedure for X-Ray machine:

1. Look for physical damage that could affect radiation shielding
(i.e., hole in the wall, broken window, broken collimator glass or shutter, any type of damage which would allow radiation leakage from the room or the machine).
2. Ensure that the x-rays are inhibited when in the Positive Beam Limitation (PBL) model and not at 40" or 72" SID.
3. Ensure that x-rays are inhibited when EXPHOLD lamp is illuminated RED.
4. When collimator filter is off, and kV is greater than 49kV, exposures must be inhibited. The READY light will turn off
5. Wipe down the x-ray control unit and a soft cloth every day before leaving.
6. Never open the x-ray control unit.
7. Never place food or drink on the X-ray Control Unit.

e) State the working principle of MRI system with neat diagram.

4m

(Diagram 2m + Working 2m)

Ans:

Diagram of MRI system:

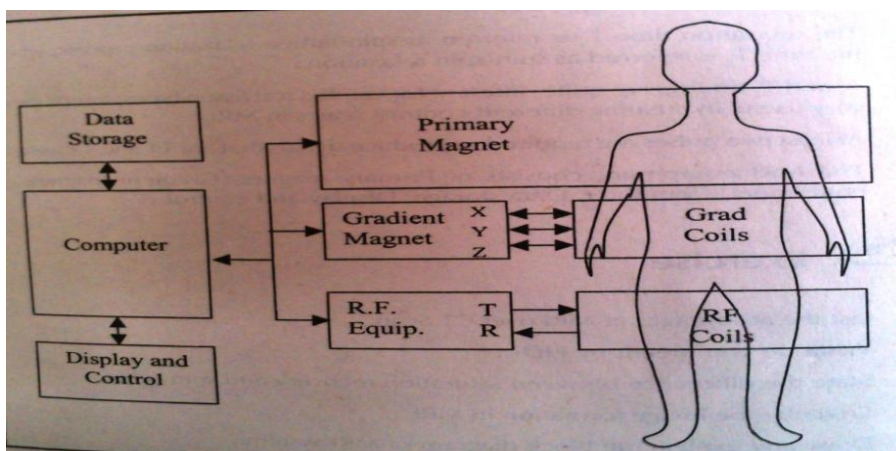


Fig: MRI scanner

Working principle of MRI system:

MRI scanner consist of

1. Primary Magnet
2. Gradient Magnet
3. R.F. equipment
4. Computer
5. Data Storage
6. Display and control.

Permanent magnet consists of either a resistive, superconductive or permanent magnet which provides the uniform magnetic field around the patient. The gradient magnet system consists of sets of x, y and z gradient magnet coils. These coils are driven by high-power audio amplifiers that can rapidly turn on and off to provide for signal localization. The R. F. equipment consists of a transmitter capable of applying RF pulses in narrow frequency bands. It has also a broad band receiver and computer controlled switching mechanism to rapidly turn on and off at the appropriate times. The computer system controls all these devices as well as performs the Fast Fourier Transform which required for assigning X, Y, Z coordinates. The data is stored as a number of arrays as a image in data storage.

Q.4 (a) Attempt any THREE of the following :

Marks 12

i) State any two types of magnets used in MRI and define the terms RF shielding shimming.

4m

(Types of magnet 2m + Define the terms RF shielding shimming 2m)

Ans:



Types of magnets used in MRI:

1. Resistive magnet
2. Permanent magnet
3. Super conductive magnet
4. Bar magnet

Define the terms RF shielding shimming:

Magnetic shielding through the use of secondary shielding coils designed to produce a magnetic field that cancels the field from primary coils in regions where it is not desired, e.g., outside the bore of the magnet. These active shielding coils may be located inside the magnet cryostat. Active shielding can be applied to the main magnet or to the gradient magnetic fields. See also Magnetic shielding, self-shielding, and room shielding. Shimming is the process of making the magnetic field more uniform by suitably adjusting the currents in shim coils.

ii) Define the term installation. Following are the faults noted in endoscopy machine give remedy **4m**
to find out faults. (Definition 2m+ Faults remedy 2m)

- 1) Light not functioning.
- 2) Occurrence of image is not clear/ Picture is cloudy.

Ans:

Definition of Installation: It is the action or process of making machine ready to be used in certain place. Installation is process that put all piece of equipment together & make it ready for use.

1. Light not functioning

- Cause:**
1. Bulb blown
 2. Fuse blown
 3. No power from socket

- Solution:**
1. Replace bulb with correct type.
 2. Replace fuse with correct rating.
 3. Check power switch is ON.
 4. Check mains power is present at socket using equipment known to be working .
Contact electrician for rewiring if power not present.

2. Picture is cloudy

- Cause:**
1. Build up of matter on the distallens.
 2. Broken fibres in cable.



- Solution:**
1. Clean the lens with an alcohol wipe.
 2. If these significantly affect use, return to manufacturer.

iii) List advantages and disadvantages of X-rays. (Any two of each) 4m

(Any two advantages 2m + Any two disadvantages 2m)

Ans:

Advantages of x-rays:

1. X-rays are used to treat malign tumors before its spreads throughout the human body.
2. They help radiologists identify cracks, infections, injury, and abnormal bones.
3. They also help in identifying bone cancer.
4. X-rays help in locating alien objects inside the bones or around them.

Disadvantages of x-ray

1. X-rays makes our blood cells to have higher level of hydrogen peroxide which could cause cell damage.
2. A higher risk of getting cancer from X-rays.
3. The X-rays are able to change the base of the DNA causing a mutation.

iv) State four steps to be carried out in installation of angiography machine. 4m

(Each step 1m)

Ans:

Installation of angiography machine:

1. Prepare lab area layout.
2. Unpack the box.
3. Read the user manual carefully.
4. Check environmental condition of room.
5. Check electrical supply of the room.
6. Assemble all the accessories of equipment
7. Mount TV camera, heat exchanger , power supply, x ray tube and attached assembly cover ,c arm unit, driver unit ,image intensifier tube.
8. Install control cabinet & mount display unit.
9. Please check alignment of x ray beam mount collimator & check its alignment.
10. Install other optional components like monitor support, remote console, console car.
11. Check the settings, inspect all the connection.
12. Perform demo test.

Q.4 (b) Attempt any ONE of the following : Marks 06

i) What are the risk factors involved in handling X-ray machine. Following are the faults noted in X-ray machine give remedy to find out faults. 6m

(Two fault remedy 3m + Two fault remedy 3m)



- 1) Machine does not work.
- 2) Radiograph do not show desired object.
- 3) More dark image or high density.
- 4) Weak image, low image density.

Ans:

X-ray machine give remedy to find out faults:

1) Machine does not work.

Cause: Mains supply is not proper.

Action taken: 1. Move position of mains compensator control.

2. Check mains fuses, faulty connection in switch replace if defective.

2) Radiograph do not show desired object.

Cause: Improper calibration

Action taken: Adjust focal spot and check collimator setting.

3) More dark image or high density.

Cause: Over exposure or over developing

Action taken: Reduce exposure and adjust developing temperature and time.

4) Weak image, low image density.

Cause: Under exposure or under developing.

Action taken: Increases exposure, adjust developing temperature and time.

ii) Differentiate between fluoroscopy and radiography based on following points.

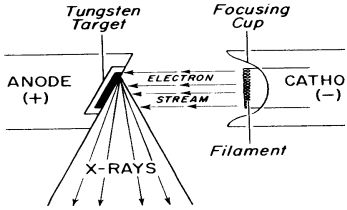
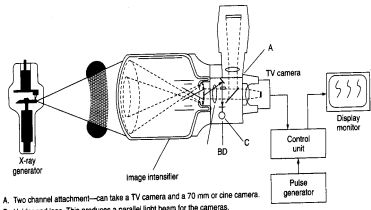
6m

(Each difference 1m)

- 1) Diagram
- 2) Working principle
- 3) Application
- 4) Viewing media
- 5) Advantages
- 6) Disadvantages

Ans:

Difference between fluoroscopy and radiography based on following points:

parameter	Radiography	Fluoroscopy
Diagram	 <p>Figure 2-4 Lateral view of the cathode : anode of a stationary anode x-ray tube</p> <p style="text-align: right;">Fig : radiography</p>	 <p style="text-align: right;">Fig: fluoroscopy</p>
Principle	<p>Radiography is an imaging technique that uses electromagnetic radiation other than visible light, especially X-rays, to view the internal structure of a non-uniformly composed and opaque object (i.e. a non-transparent object of varying density and composition) such as the human body</p>	<p>Fluoroscopy is a technique for obtaining "live" X-ray images of a living patient - it is like an X-ray TV camera. The Radiologist uses a switch to control an X-Ray beam that is transmitted through the patient. The X-rays then strike a fluorescent plate that is coupled to an "image intensifier" that is (in turn) coupled to a television camera. The Radiologist can then watch the images "live" on a TV monitor</p>
Viewing media used	<p>Radiographic film</p>	<p>TV camera</p>
Advantages	<ol style="list-style-type: none"> 1. Accurate Diagnosis 2. Nondestructive 3. Pictorial Presentation of Information 4. Portable 5. Versatile Applications 	<ol style="list-style-type: none"> 1. Allows a physician to see a live image of the body's internal organs in order to observe their size, shape and movement. 2. Provide dynamic and functional information. 3. Readily available. 4. Inexpensive. 5. Allow real time interaction. 6. Good for visualized bony structure.
Disadvantages	<ol style="list-style-type: none"> 1. Very small increased risk of cancer in future from exposure to ionizing radiation (x-rays). 	<ol style="list-style-type: none"> 1. Although radiation is minimal, there is the chance of skin injury due to radiation exposure, as well as the usual risks associated



	<p>Risk is greater for children</p>	<p>with radiation.</p> <ol style="list-style-type: none"> 2. May display overlapping anatomy. 3. May be limited by patient mobility and ability to comply. 4. Poor soft tissue resolution. 5. Use ionizing radiation.
<p>Application (any one or two)</p>	<ol style="list-style-type: none"> 1. X ray: x rays are used for to detect cracks, fractures in bones. 2. It is also used for killing cancerous cells 3. CT scan: CT scanning is used for diagnosing some urgent and emergent conditions, such as cerebral hemorrhage, pulmonary (clots in the arteries of the lungs), aortic dissection (tearing of the aortic wall), appendicitis, diverticulitis, and obstructing kidney stones. 4. Ultrasound: it is used for obtain images of almost entire range of internal organs in abdomen .development of fetus during development. 5. Thermmography: it gives video of temperature distribution over the surface of the skin. 6. NMI: used to detect biochemical process are occurring normally and where they are occurring too slowly or quickly. 7. MRI: To obtain anatomical information about human body 	<ol style="list-style-type: none"> 1. To obtain real-time moving images of the internal structures of a patient 2. Investigations of the gastrointestinal tract, including barium enemas, defecating proctograms, barium meals and barium swallows, and enteroclysis. 3. Orthopedic surgery to guide fracture reduction and the placement of metalwork. 4. Angiography of the leg, heart and cerebral vessels. 5. Placement of a PICC (peripherally inserted central catheter) 6. Urological surgery 7. Cardiology for diagnostic angiography, 8. Implementation of pacemakers, implantable cardioverter defibrillators and cardiac resynchronization devices) 9. Discography, an invasive diagnostic procedure for evaluation for intervertebral disc pathology.

Q.5 Attempt any FOUR of the following :

Marks 16

a) With neat labeled diagram explain working of gamma camera.

4m

(Diagram 2m+ Working 2m)

Ans:

Working of gamma camera:

The gamma camera is a stationary imaging device as opposed to the rectilinear scanner in which the detector is made to move over the organ of interest. It consists of following functional components

Detector: This consists of a collimator, crystal, photomultiplier tubes, position localization circuitry.

Camera electronics:

When a photon of the radiation leaves the patient body it passes through the collimator and interacts a crystal wherein its energy is converted into light. The light from the crystal is received by photomultiplier tubes and converted into an electrical signal. The electrical signal passes through the position localization circuitry whose output consists of x and y positional signals and a energy signal.

Hundreds of thousands of photons leave the patient's body and strike crystal, each causing a black spot to be formed on the film.

Diagram of gamma camera:

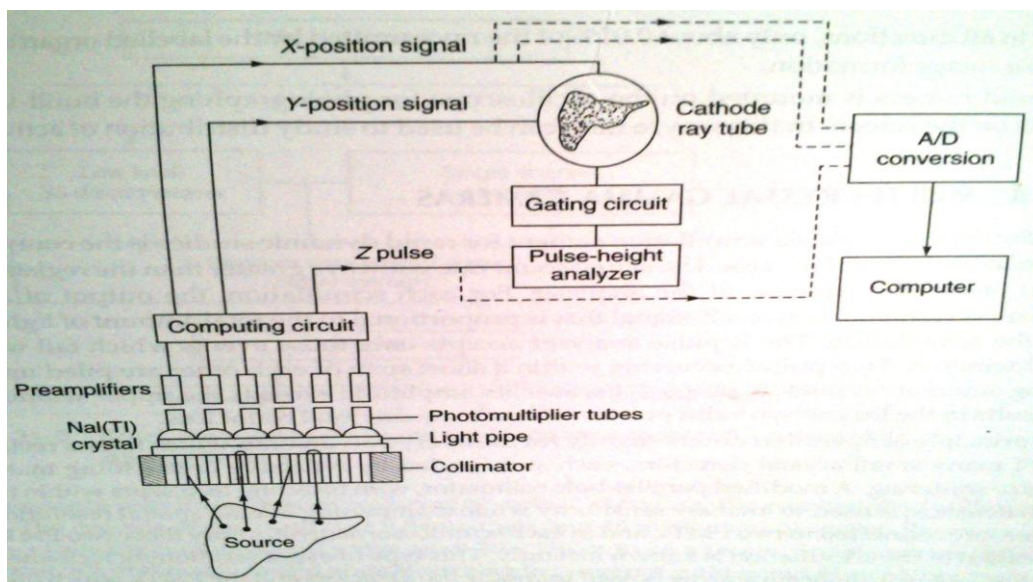


Fig : Gamma Camera

b) Draw a neat labeled diagram and state working of B - scanner technique of ultrasound.

4m

(Diagram 2m +Working 2m)

Ans:

Diagram of B - scanner technique of ultrasound:

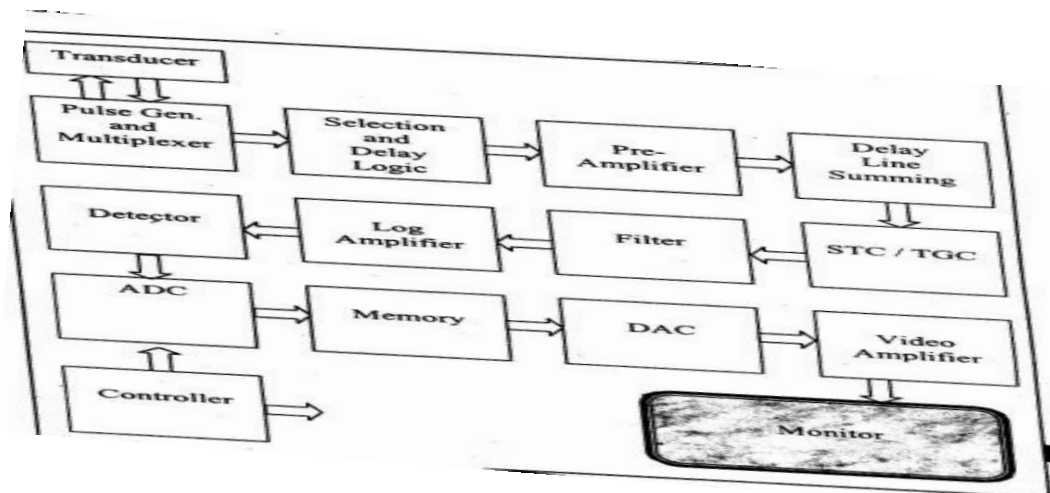


Fig: B - scanner technique of ultrasound

Working of B - scanner technique of ultrasound:

It consist of following blocks:

1. Pulse generator and multiplexer
2. Selection and delay logic
3. Preamplifier
4. Delay line summing
5. STC/TGC
6. Filter
7. Log amplifier
8. Detector
9. ADC
10. Memory
11. DAC
12. Video amplifier
13. Monitor
14. Controller

The transducer generates the ultrasonic beam by high voltage pulses using pulse generator through array of multiplexer which is automatically selected by a system. then it is prepare to receive the echoes. the echoes from the body are then converted into into electric signal. these signals are amplified by a pre amplifier and fed to the delay line in order to fit the phase and then summed upto this stage signal is processed according to the depth of intrest by sensitivity time control.



To obtain an image of good quality TGC is [performed. Signal is then fed to the filter to reduce the noise and adjust the final quality of constructed image.

Filter signal is further fed to the log amplifier to compress the signal. Envelop detector detects the envelope of the echo signal and convert it into the digital signal. this digital signal is fed to the digital memory according to the address of the position of the beam. Finally data is read out from the memory and converted to video signal which is further fed to cathode ray monitor and displayed.

c) Write any four biological effects of MRI.

4m

(Each effect 1m)

Ans:

Biological effects/hazards of MRI imaging:

1. If patients with cardiac pacemakers, cerebral aneurysm clips or other metallic foreign body undergo for MRI then due to strong magnetism, these devices can malfunction or get damaged.
2. Implanted electrode such as neuro stimulator and bone growth stimulator or internal drug diffusion pump
3. Time varying magnetic fields induce currents in patients which can produce muscle contraction and cardiac arrhythmia.
4. It can cause the augmentation in T wave of ECG.
5. It can cause deafness in the patient

d) Write four steps for installation of X-Ray equipment.

4m

(Each step 1m)

Ans:

Steps for installation of X-Ray equipment :

1. The basic radiological system designed by world health organization.
 - For x ray laboratory minimum two room are required i.e. x ray tube and dark room
 - The BRS is also specify the difficult requirements for the x ray system i.e. it deals with different components of x ray.
 - The floor plan for 3 or 2 rooms is suggested by BRS
2. Dark room requirement
 - For manual processing the dark room should have floor area of 5m²
 - For automatic processing the dark room should have floor area small dimensions.
 - The dark room must have entirely light proof arrangement even with the bright sunlight.
 - The different light sources require in dark room & the paint used in dark room is also has to be consider while designing the x ray dark room

3. Electrical supply

- Check the characteristics of available power supply while connecting the x ray generator to AC mains.
- The main power cord has proper connectors instrument is properly grounded.

4. Different components of x ray machine.

5. Safety precaution s for radiation hazards.

- Operating control panel has in its front a protective lead screen with lead glass window minimum size 30*30

e) With a neat labeled diagram explain working of high voltage control circuit for X-Ray.

4m

(Diagram 2m+ Working 2m)

Ans:

Diagram of high voltage control circuit for X-Ray machine:

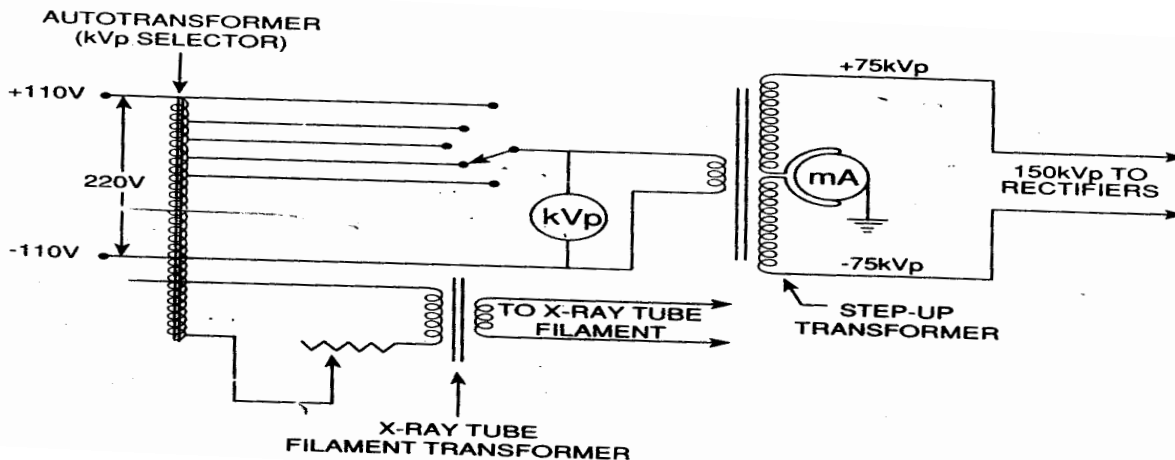


Fig: High voltage control circuit

Working of high voltage control circuit for X-Ray machine:

The high voltage control circuit has two transformers, an autotransformer and a step up transformer. The autotransformer is actually the KVp selector and it is located in the control panel. The voltage across the primary coil of the step-up transformer can be varied by selecting the appropriate no. of turns in the autotransformer. The KVp can be adjusted in steps from approximately 40-150Kvp.

The step up transformer called as high voltage transformer, has many more turns in the secondary coil that in the primary coil and it increases the voltage by a factor of approx. 600.



f) State the significance of CT number and list any two medical application of CT machine.

4m

(Significance 2m + Applications 2m)

Ans:

Significance of CT number:

CT-number It is normalized value of the calculated x-ray absorption coefficient of a pixel (picture element) in a computed tomogram, expressed in Hounsfield units, where the CT number of air is -1000 and that of water is 0.

$$\text{CT number} = \frac{\mu_{\text{voxel}} - \mu_{\text{water}}}{\mu_{\text{water}}} \times 1000$$

Medical applications of CT machine:

1. Organs such as stomach, gall bladder, liver, spleen, pancreas, kidneys, lower gastrointestinal (GI) tract, the colon and rectum can be visualized with great clarity using CT imaging of the abdomen.
2. They are used for the diagnosis of appendicitis, stage of cancer, tumors and gangrene.
3. CT scan is used for the diagnosis of Alzheimer's disease, brain tumors, bleeds, injuries to the brain and other major brain diseases. Computed Tomography Angiography helps in the visualization of blood flow in the arteries throughout the body. It is used in the diagnosis of aneurysms (bulging), stenosis (narrowing) of the arteries, dissection of the aorta etc.
4. CT scan are used to take images of multiple tissues such as lungs, heart, bones, muscles, blood vessels, soft tissues etc. These images are used to detect acute and chronic changes in lung parenchyma, diagnose tumors, emphysema, inflammations etc.

Q.6 Attempt any FOUR of the following:

Mark 16

a) Write any four medical application of X-ray.

4m

(Each application 1m)

Ans:

Medical applications of X-ray:

1. Radiation therapy: It is the treatment using penetrating x-rays, on the affected region of the body to destroy the cancer cells. Radiation therapy is a modern treatment technique where the results are faster with fewer side effects than other more traditional forms of treatment. Depending upon the position of the radiation source, different types of treatments are used.
Radiography: It is the use of ionizing electromagnetic radiation such as X-rays to view objects.
2. X-rays of bony injuries are looked at by the radiologist for signs of hidden trauma (for example, the famous "fat pad" sign on a fractured elbow).



3. Dental radiography uses a small radiation dose with high penetration to view teeth, which are relatively dense.
4. Mammography is an X-ray examination of breasts and other soft tissues. This has been used mostly on women to screen for breast cancer
5. Angiography is the use of fluoroscopy to view the cardiovascular system. An iodine-based contrast is injected into the bloodstream and watched as it travels around. Since liquid blood and the vessels are not very dense, a contrast with high density (like the large iodine atoms) is used to view the vessels under X-ray.
6. Dual energy X-ray absorptiometry

DEXA, or bone densitometry, is used primarily for osteoporosis tests.

b) With a neat labeled diagram explain working of CT machine.

4m

(Diagram 2m+ Working 2m)

Ans:

Working of CT machine:

Block diagram of CT scanner consist of following parts

1. X ray tube
2. Collimator
3. Detectors
4. Measuring electronics
5. Display

1. **X ray tube:** radiation source for CT is produced by the x-ray tube. X ray tube with rotating anode and with much smaller focal spot is used. they have large heat loading and heat dissipation capacity. X rays produced by the x ray tube are passed through the collimator.

2. **Collimator :** the x ray beam is collimated at two point's one close to the x ray tube and others at detectors Perfect alignment between two is essential collimators at the detectors are used for the controlling the scattered radiation.

3. **Detectors:** radiation passed through the patient body is collected by the detectors.

4. **There are two types of detectors:** scintillation crystal and xenon gas ionization chambers Detectors must be coupled with photodiode. Detectors convert x radiation into electrical signal. This electrical is given to the measuring electronics and display.

5. **Display unit:** signals coming from the measuring electronics are displayed on video monitor as a video. X ray source and detectors are mounted opposite each other in rigid gantry with the patient lying between, and by moving one or both these around and across the relevant sections which is how the measurements are made. The patient lies on a monitorised couch and is moved into the apertures of the gantry with the location to be accurately determined by the means of a narrow strip light that falls on a patient body from the gantry and illuminates the section to be examined From the keyboard mounted on operating consol.

Diagram of CT machine:

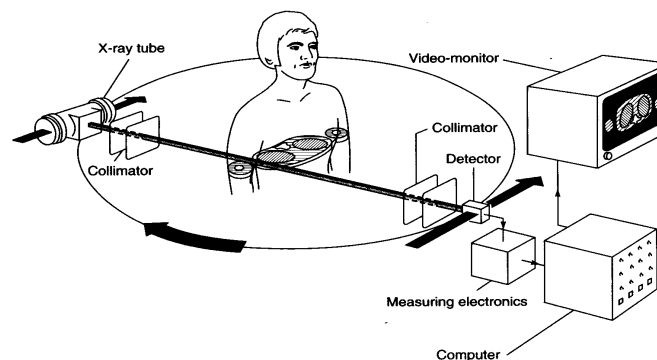


Fig: Diagram of CT machine

c) State any four properties of ultrasound.

4m

(Each property 1m)

Ans:

Properties of ultrasound:

1. **Wavelength-** the length of the wave is the distance between two bands of compression or rarefaction.
2. **Velocity of sound-** it depends on the type of material through which the sound is being transmitted.
3. **Compressibility-** the less compressible material, the more rapidly it transmits the sound.
4. **Intensity-** the greater the amplitude of oscillations the more intense the sound.
5. **Density-** the more dense material, the more rapidly it transmits the sound.

d) List four steps for maintenance of endoscopy machine.

4m

(Each step 1m)

Ans:

Maintenance steps of endoscopy machine:

1. Flush, rinse, dry & disinfect endoscope after every use.
2. Remove any tape, paper or foreign body from equipment
3. Check all accessories & fittings are properly connected.
4. Check there are no signs of damage to the flexible tube.
5. Store in correct packing for protection.
6. Check operation of controls & tubes before use.



7. Unplug light source, clean with damp cloth & dry off.
8. If any plug , cable or socket is damaged ,replace it.
9. Check proper operation of all control, indicators & lamps.
10. Check sturdiness of trolley if used.

e) Write stepwise installation procedure for ultrasound machine.

4m

(Each step 1m)

Ans:

Installation procedure for ultrasound machine:

Steps involved are as follows

1. Prepare lab area for installation machine.
2. Check electrical supply connection.
3. Unpack the box.
4. Read user manual carefully.
5. When equipment arrives, it will be necessary to record the fact and to check that everything has been supplied that was ordered. It will also be necessary to check that the equipment is supplied in the right way.
6. Assemble all accessories of equipment.
7. Connect monitor scan control panel and ultrasound probes.
8. Check position of curser on the monitor by placing the electrode on sample.
9. Perform quality test on equipment.
10. Perform demo test.