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.

Q. 1. a) Attempt any 3 (12)

1) State the basic difference between nuclear imaging and other imaging modalities. List the transducer used in nuclear medicine imaging. 4m

(difference-2m+list-2m)

Ans:

Difference:

The main difference between nuclear medicine diagnostic tests and other imaging modalities is that nuclear imaging techniques show the physiological function of the tissue or organ being investigated, while traditional imaging systems such as computed tomography (CT scan) and magnetic resonance imaging (MRI scans) show only the anatomy or structure.

Nuclear medicine imaging techniques are also organ- or tissue-specific. While a CT or MRI scan can be used to visualize the whole of the chest cavity or abdominal cavity, for example, nuclear imaging techniques are used to view specific organs such as the lungs, heart or brain. Nuclear medicine studies can also be whole-body based, if the agent used targets specific cellular receptors or functions. Examples of these techniques include the whole-body PET scan or PET/CT scan,

Transducers used in Nuclear Medical Imaging are

1) Geiger muller tube detector

2) scintillation counter

3) semiconductor detector

4) xenon gas detector

2)Write four steps to be carried out for installation of ultrasound machine.

(steps-4m) 4m

Ans:

Steps:

1) Consider your plans for the ultrasound machine.

2) Look for the technical specifications you need.

3) Think about the size you need.

4) shop with well known providers of medical equipment.

5)Buy an ultrasound machine that has a warranty & a return policy.

6) Buy your ultrasound machine from a reputable dealer.

3)With a neat labelled diagram explain MRI detection system.

(diagram-2m + explanation-2m) 4m

Ans:

Diagram:

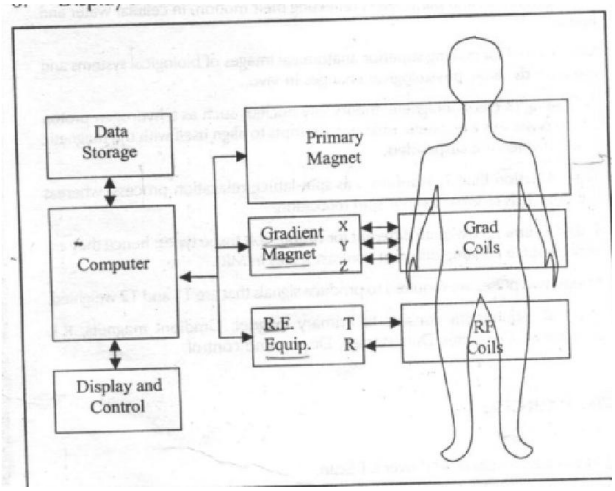


Fig: MRI detection system

It consist of primary magnet, gradient magnet, RF equipment, computer, data storage, display and control.

Explanation:

Block diagram of MRI scanner consists 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 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.

4)Following are the faults noted in endoscopy machine give remedy to find out the fault.

1) No fluid flow or suction through scope

2)Picture is cloudy

3)Light not functioning

4)Fluid invasion

(each-1m) 4m

Ans:

1)No fluid flow or suction through scope

Cause : blocked air /water nozzle. Loose or damage setscrew.

2)Picture is cloudy

Cause : Humidity may have introduced into camera head's connecting plug. Carefully dry the camera head at 60°C for 30 minutes .

3)Light not functioning

Cause : Compare the light-guide cable's light transmission with that of a new light guide cable. Inspect the connector to be plugged into light source.

4)Fluid invasion

Cause : Perform the leak test before immersion of the endoscope in reprocessing solutions to minimize damage to endoscope.

Q. 1. b) Attempt any 1 (6)

1)Draw block diagram of Angiography system state function of each block and state its two advantages.

(diagram-2m + explanation-2m + advantages-2m)

Ans:6m

Description :

Angiography is a diagnostic and rapidly developing therauptic modality concerned with diseases of circulatory system. The procedure is carried out by using a contrast material to opacify vascular structures because the radiographic contrast of blood is essentially the same as that of soft tissue. Contrast material is an iodine-containing compound which is injected through a catheter .Radiographic images of the contrast-filled vessels can be viewed on the TV screen or are recorded by using either film or video.

Block diagram of Digital substractionAngiography(DSA)Technique

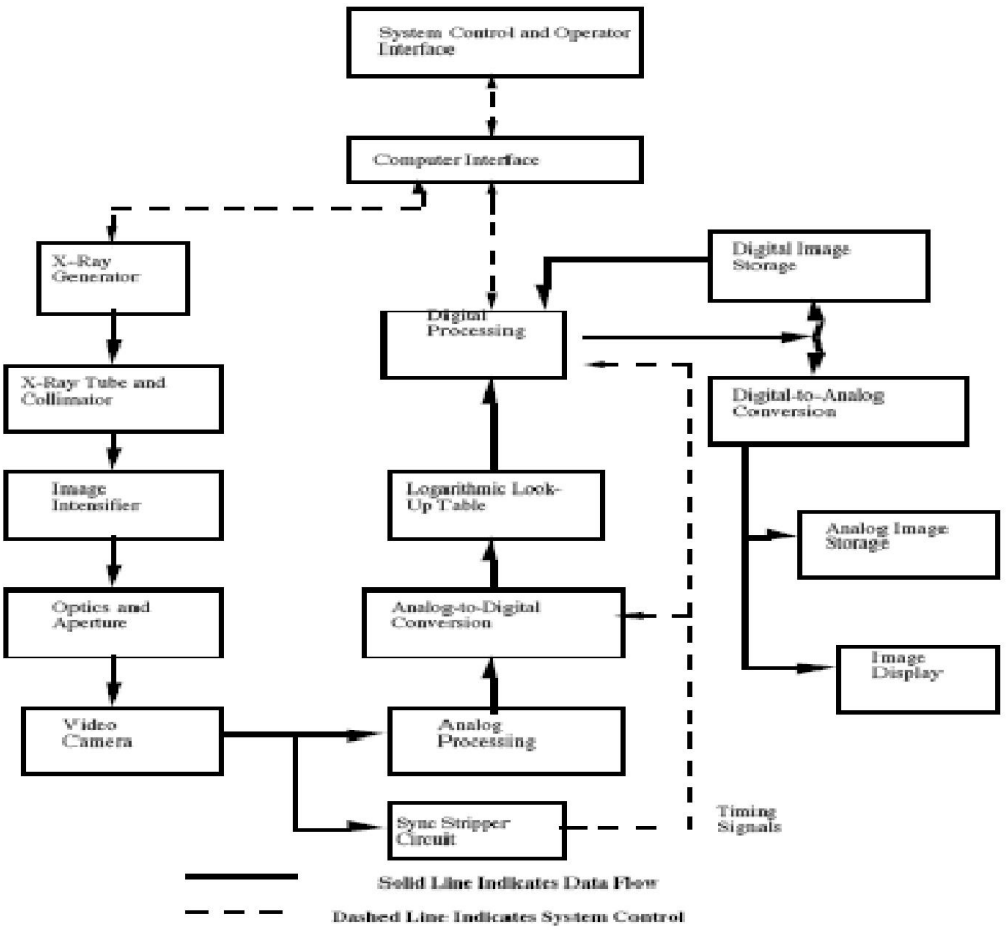


Fig: Block diagram of Digital substraction Angiography

OR

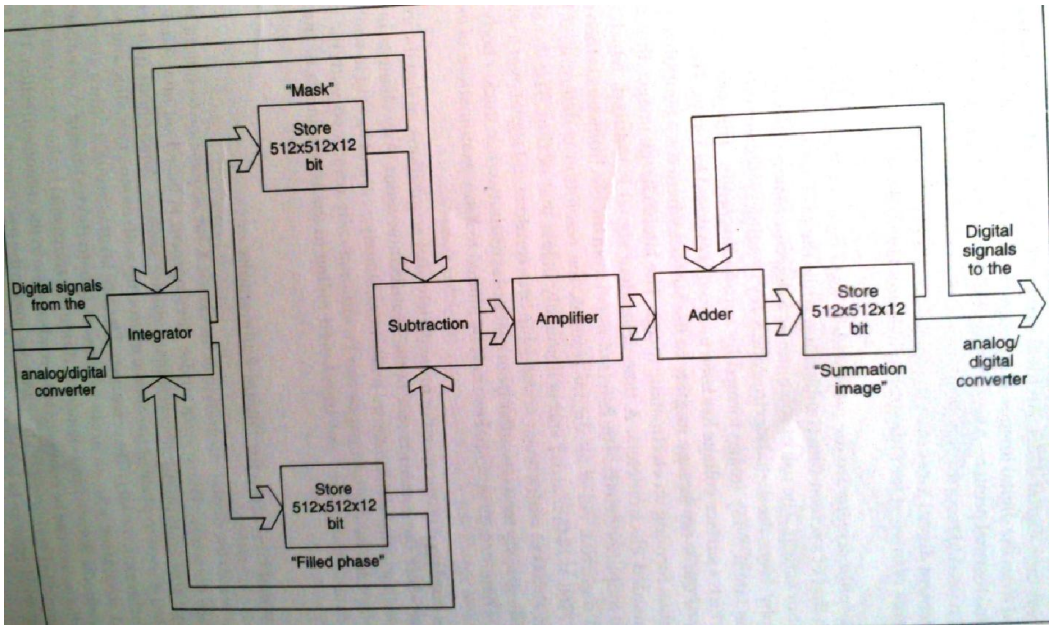


fig: digital subtraction angiography

A technique that is known as digital subtraction angiography but which is also referred to as digital radiography, digital fluoroscopy, and photoelectronic imaging. Digital subtraction angiography refers specifically to techniques which subtract two images that are obtained before and after contrast media is administered to the patient for the purposes of studying blood vessels (angiography). The more general term, digital radiography encompasses the use of all digital electronic techniques in x-ray imaging. A general system diagram for a digital radiographic system is given in Figure above. At the heart of this system is a digital image processing system which acquires images from a video camera and provides timing signals to both the x-ray generator and the image acquisition system to control the flow of data from the x-ray source into the image processor.The image acquisition process begins when timing signals,delivered to the x-ray generator under computer control,initiates the production of x-rays which are transmitted through the patient and received by the image intensifier. An aperture, placed between the image intensifier and the videocamera, controls the amount of light delivered to the camera. A video camera receives the light image from the image intensifier and converts it to a electronic video signal which is delivered to the image processor in analog form. The image processor digitizes the image, stores it in memory, and makes it available in digital form for subtraction with another image set acquired at a different time or at a different energy. The basic components of the imaging system including the x-ray tube and x-ray generator, the image intensifier, and the video camera are similar to but must be of higher quality than those used in conventional fluoroscopy to ensure proper synchronization and match between analog and digital components.A common algorithm using digital

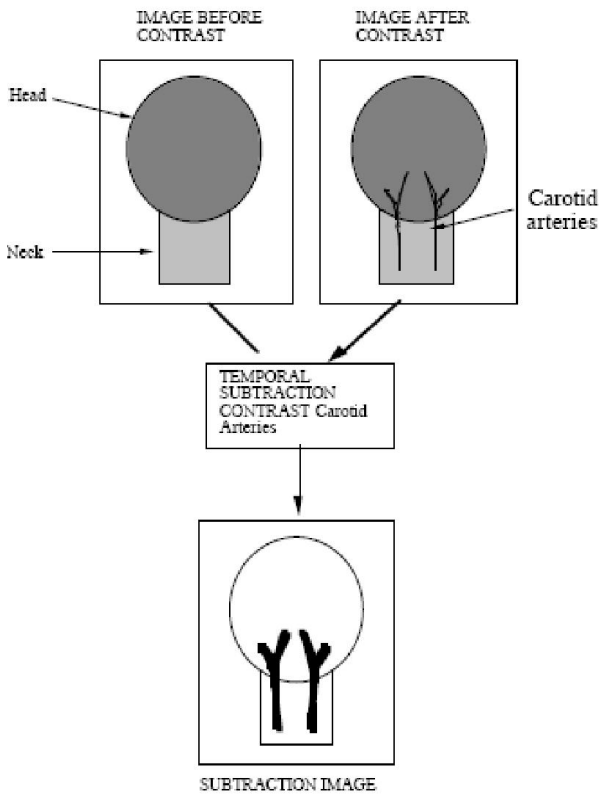


Fig:digital subtraction angiography

In this technique, dynamic images of the patient are acquired at a rate of 1 exposure per second or more. A contrast agent is injected into the patient either intravenously or intra-arterially. A second set of dynamic images is acquired after the contrast agent flows into the area being imaged. The unopacified

images (no contrast) are subtracted from the opacified images with the subtraction process isolating the signal (which is present only in the opacification image), removing the static anatomical structures that are common to both the opacified and unopacified images. The elimination of background structures makes the arteries visible in the subtraction image even when they are not visible or barely visible before subtraction.

advantages of angiography system:

1) Angiography is the x-ray (radiographic) study of the blood vessels. An angiogram uses a radiopaque substance, or contrast medium, to make the blood vessels visible under x ray.
2) The key ingredient in most radiographic contrast media is iodine.

Arteriography is a type of radiographic examination that involves the study of the arteries.

2)What is exposure timer? List types of timer circuits used in X-ray machine .explain any two types of exposure timer used in X-ray machine.

(definition-1m + List-1m + explanation-4m) 6m

Ans:

Exposure timer:

Exposure time is the length of time when the film or digital sensor inside the camera is exposed to light, also when a camera's shutteris open when taking a photograph .The amount of light that reaches the filmor imagesensor is proportional to the exposure time.

OR

In any given radiographic examination, the quantity of X-rays reaching the film is directly related lo the X-ray tube current and the time for which the tube is energized i.e. the exposure time.

List types of timer circuits:

1) Mechanical timer
2) Digital timer
3) Electronic timer
4) Photo timer

1) Digital timer:

Reference oscillator provides one of the input to the logic gate (AND) another input for this AND gate is taken from the start point. When the start point signal is high the output of gate is high which initiates the counter. The status of counter is continuously match with predetermined logic. When these both values are same the pulse generates which triggers stop signal for the gate. In this way we get a output for only that duration which is set by predetermined logic. also there is a provision to stop the timer in between.

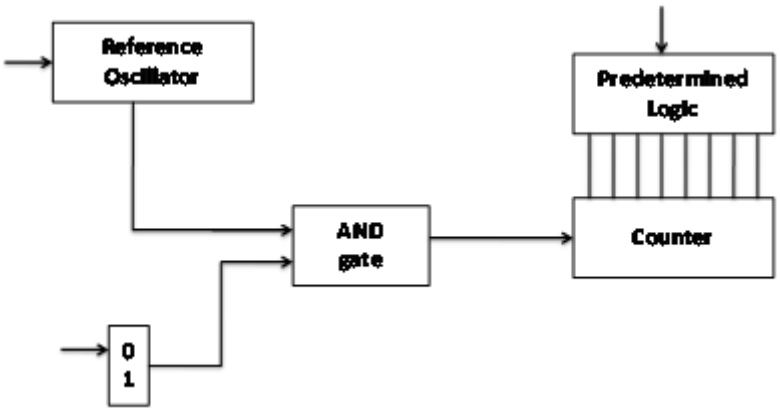


Fig: digital timer

Mechanical timer :

Mechanical timers use clockwork to measure time.Manual timers are typically set by turning a dial to the time interval desired; turning the dial stores energy in a mainspring to run the mechanism. They function similarly to a mechanical alarm clock; the energy in the mainspring causes a balance wheel to rotate back and forth. Each swing of the wheel releases the gear train to move forward by a small fixed amount, causing the dial to move steadily backward until it reaches zero, when a lever arm strikes a bell. The simplest and oldest type of mechanical timer is the hourglass, in which a fixed amount of sand drains through a narrow opening from one chamber to another to measure a time interval.

Fig: Mechanical timer

Q. 2. Attempt any 4(16)

a) **State any four clinical applications of CTscan .** **4m**

(explanation-4m)

Clinical applications of CT scan are as follows :-

1) Cerebral Scans-One of the most important applications of CT is in the head trauma it is used to investigate possible skull fractures, underlying the brain damage or hemorrhage.

2) Pulmonary Disease-CT is particularly useful in the detection of pulmonary disease because lung imaging is extremely difficult using ultrasound and magnetic resonance imaging. CT can detect pulmonary malignancies as well as emboli and is often used to diagnose diffuse diseases of lungs such as silicosis, fibrosis etc.

3) Abdominal Imaging-Compound fractures in organs such as pelvis,which occur commonly in elderly patients,can be visualized in three dimensional using CT.

4) It is also very useful in the detection of abdominal tumors and ulcerations in the liver.

b)State the principle of A scan..4m

(explanation-4m)

Ans:

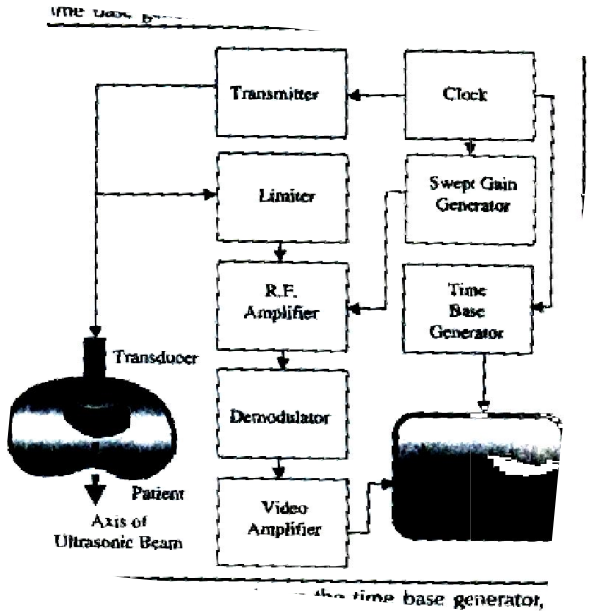


Fig: A scan

Explanation:

A scan imaging is a technique of transmitting a train of short duration ultrasonic pulses into the body and detecting the energy reflected by a surface. In this technique reflected echoes from the body structure are detected and then displayed on vertical axis of the horizontal sweep.

Ultrasonic A-scan provides one-dimensional information.

In A-scan technique use 1-10 MHz frequency waves.

It consists of clock, transmitter, limiter, RF amplifier, demodulator, swept gain generator, video amplifier, time base generator.

Clock simultaneously triggers the time base generator, transmitter and swept gain generator.

Transmitter generates a train of short duration pulses at repetition frequency determined by the clock. these electrical pulses are then converted intocorresponding ultrasound pulses by piezoelectric crystal acting as transducer and injected into patient body. Echoes of ultrasound are converted into into electrical, signal by the same transducer. thentheses signals are amplified suitably by a RF amplifier. The swept gain generator increase the gain of RF amplifier with time to correct the amplitude of echo according to depth of echo producing target. Output of RF amplifier is demodulated and fed to the video amplifier to display on CRT tube Y deflection plate. x plate is driven by the time base.

c)Draw a neat labeled diagram and state each working of thermography machine.4m

(diagram-2m + explanation-2m)

Ans:-

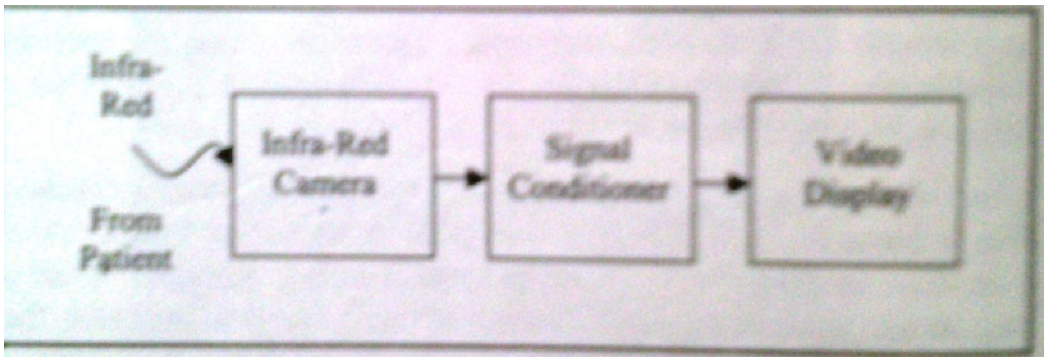


Fig: Thermography machine

Infra red cameras use photoconductive or photovoltaic cells to convert the IR radiations being emitted from the surface of the body under examination in to a electrical signal. This electrical signal then processed by a signal conditioner and displayed using a video monitor.

Scanning in camera is achieved by dividing a object field in to a number of horizontal lines. A segment of object field is reflected in to a plane mirror and then on to the detector. By moving the mirror in vertical and horizontal axis complete frame information is gathered.

The electrical signal output from the detector is converted in to a video signal and processed in signal conditioner to drive the CRT.

d) Sketchsymbols , label terminal and sketch V- I characteristics of SCR& DIAC.(4m)

Ans:

Symbols , label terminal and sketch V- I characteristics of SCR &DIAC. :

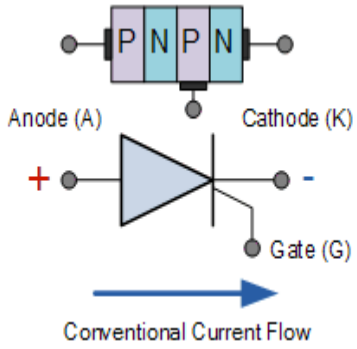
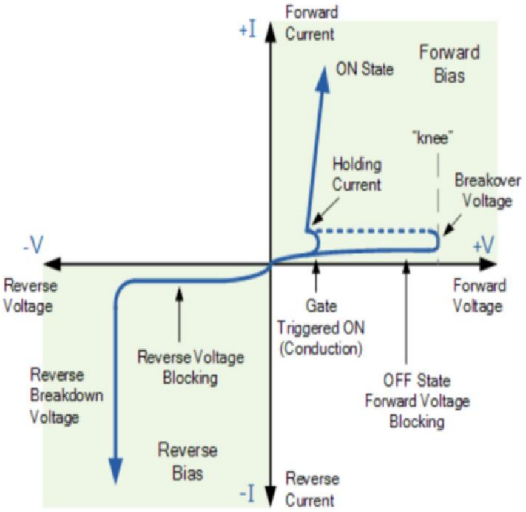
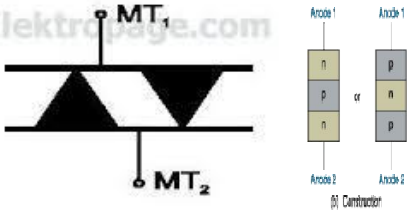
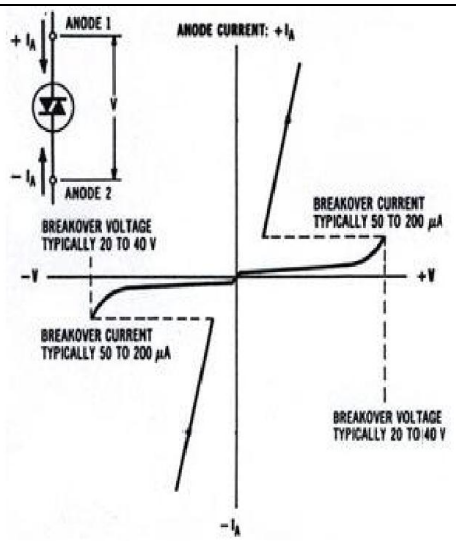
Symbol	VI characteristic
 SCR	
DIAC 	

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

e)Define the term maintenance and list the steps involved in maintenance of angiography machine. (Defination-1m + steps-3m) 4m

Ans :

Maintenance :

It is the procedure which should be carried out regularly or after the periodic time decided by the manufacturer of the machine to ensure normal operation of the machines. It includes general cleaning and checking of parts of machine along with some calibration test. Maintenance may be of regular type or preventive type.

Maintenance of angiography:

- Maintenance must be performed in the normal mode.
- Check Program: Check Program must be performed in the normal mode.
- perform calibration and maintenance with a personal computer, it is necessary to
- prepare the following:
- Personal computer where the Windows 95 / 98 has been installed.
- 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.
- Check calibration for motor of arm
- Check calibration of position table for its up down movement.
- Check collimator alignment and its position
- Check x ray tube alignment & its position.
- Check shutter & filter calibration.
- Check battery & maintain cover.
- Update software periodically.
- Check TV camera connections ,IIT,XRAY TUBE

(any other relevant answer should be consider as a valid answer)

f) State the risk factors involved in handling CT and MRI machines.

(risk factor CT-2M + risk factor MRI-2m) 4m

Ans:

1)Risk factor CT: CT scans include the risks from exposure to ionizing radiation. The exposure to ionizing radiation may cause a small increase in a person's lifetime risk of developing cancer.

A special dye called a contrast material through a vein in arm of patient before CT scan which can cause medical problems or allergic reactions.

2)Risk factor MRI: Metallic chips, materials, surgical clips, or foreign material (artificial joints, metallic bone plates, or prosthetic devices, etc.) can significantly distort the images obtained by the MRI scanner.

Patients who have heart pacemakers, metal implants, or metal chips or clips in or around the eyeballs cannot be scanned with an MRI because of the risk that the magnet may move the metal in these areas.

Q. 3 Attempt any 4 (16)

a) Draw a neat labeled diagram and state the working of linear and phased array transducer. 4m

(diagram-2m + explanation-2m)

Ans :

Real time 2-dimensional scanner is use to study the moving structures of the body parts.

There are two types of transducers or probes used in real time scanners

1) Multiple Element Linear Array

2) Multiple Element Phased Array

1) Multiple Element Linear Array –

The multiple element linear array transducer consists of 20 – 64 tiny crystals arranged in a line like a comb. The length of such transducers is around 50 to 170 mm. they are excited in group of 3 or 4

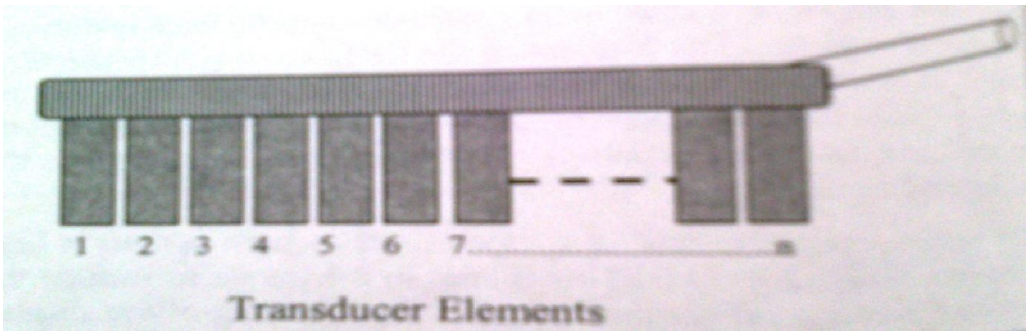


Fig : Multiple Element Linear Array

2) Multiple Element Phased Array –

The multiple element phased array consists of around 5 tiny crystals.

In this individual elements are excited with predetermined delays thus allowing to 'deflect' the beam electronically.

In this system each transducer crystal emits a cylindrical wavelet and resultant beam is directly proportional to the wave front. When delays between excitation of elements are changed different angles of the beam are obtained. The received echoes are also corresponding delayed. When the operation is repeated rapidly for different angles, an 'electronic sector – scan' image is obtained.

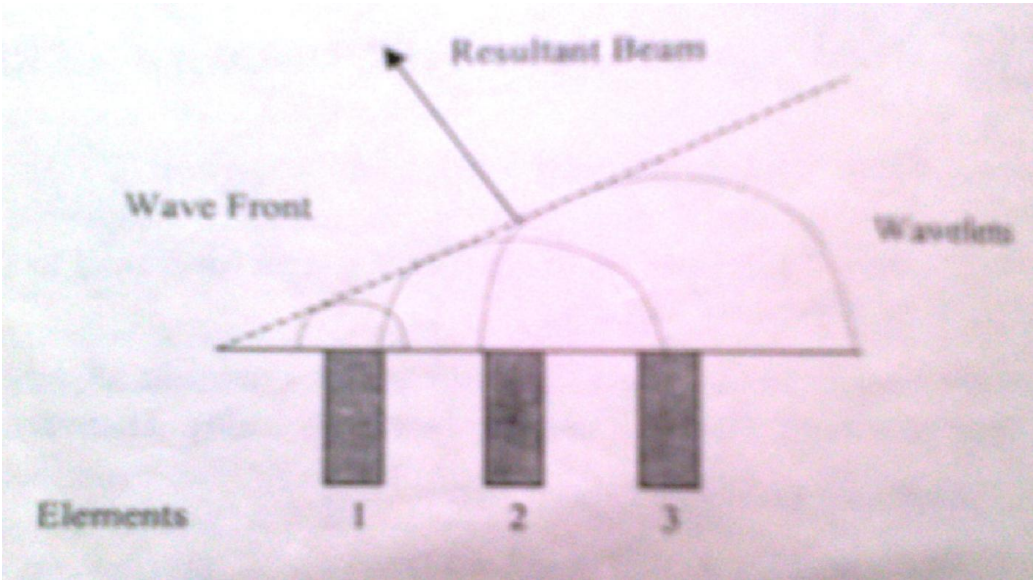


Fig :Multiple Element Phased Array

b)**Draw block diagram of endoscopy machine and state its working principle. 4m**

(diagram-2m + explanation-2m)

Ans:-

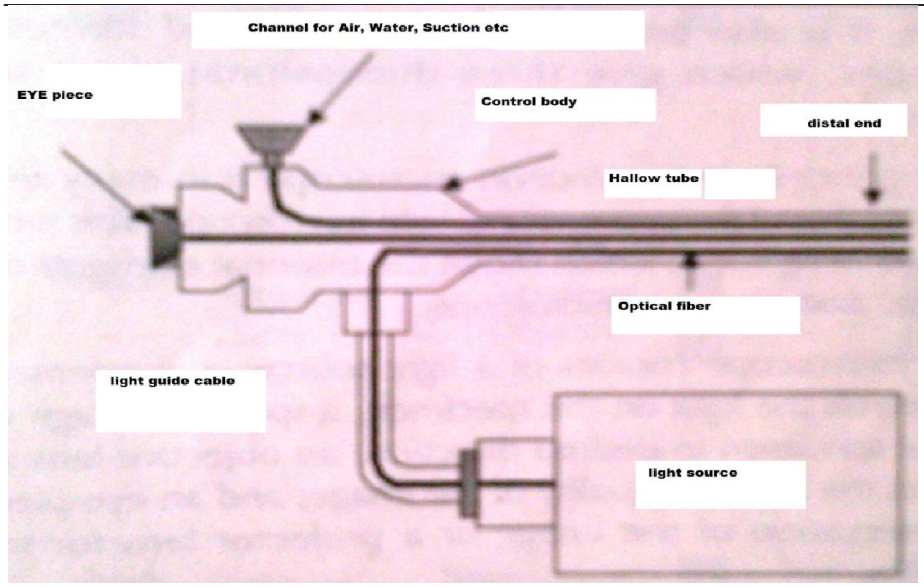


Fig: diagram of endoscopy

Endoscope is the flexible tube which can be enter into the body through natural opening or incision.

- Light source is usually a halogen lamp which provides good quality light for investigation of the organ.
- An fiber optic carries the from the light source to illuminated area in front of its distal tip.
- The reflected light from the distal tip that is image is transferred through another optical fiber to the eyepiece for viewing.

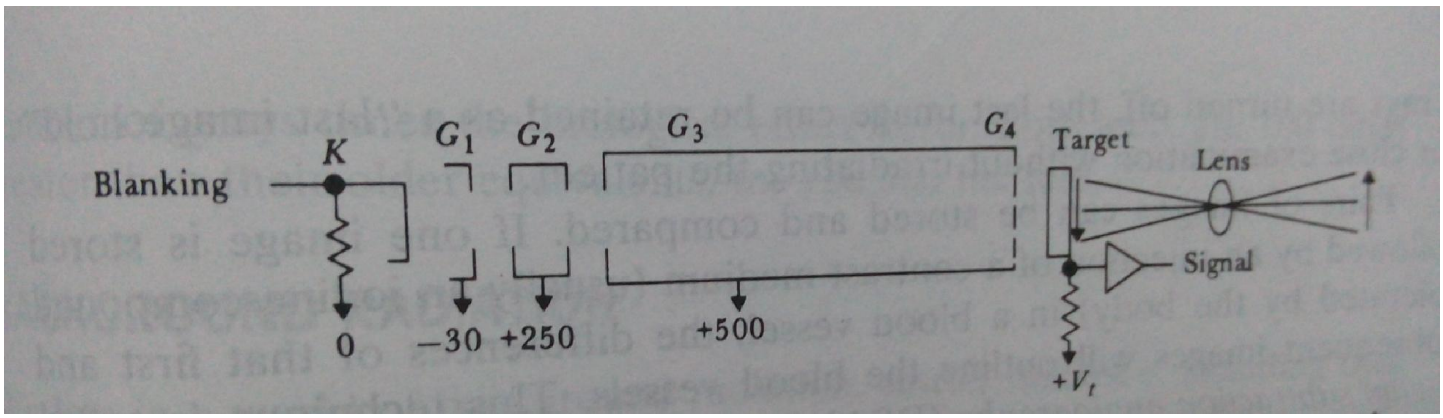
The control mechanism provides control over the endoscope to control channels of air, water, biopsy and suction.

c) Describe the working of television camera with suitable diagram.

(diagram-2m + working-2m) 4m

Ans:

Diagram:



Working: The Vidicon has a cathode and a series of grids to form shape and control an electron beam. Magnetic deflection scans the beam over the target ,which is mounted on the interior of the glass face plate. From the target, light-modulated signal current flows through the load resistor and is amplified.

The sensor or target of a camera tube is a thin layer of a photoresistor such as antimony trisulphide.

The tube has a hot cathode electron source which operates at near ground potential. The control grid G_1 surrounds the cathode and modulates electron beam. An accelerating electrode G_2 provides an electric field, which attracts the cathode electrons. The electrode has a very small hole: the beam forming aperture. A metal cylinder G_3 may have a separate mesh at the end of cylinder G_4 to provide a uniform electric field with room to magnetically deflect the beam by two orthogonal deflection coils and an axial magnetic field coil for focusing.

d) Write stepwise procedure for maintenance of X-ray machine .(any four steps).

(steps-4m) 4m

Ans:

Steps:

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 with suitable diagram. 4m

(diagram-2m + explanation-2m)

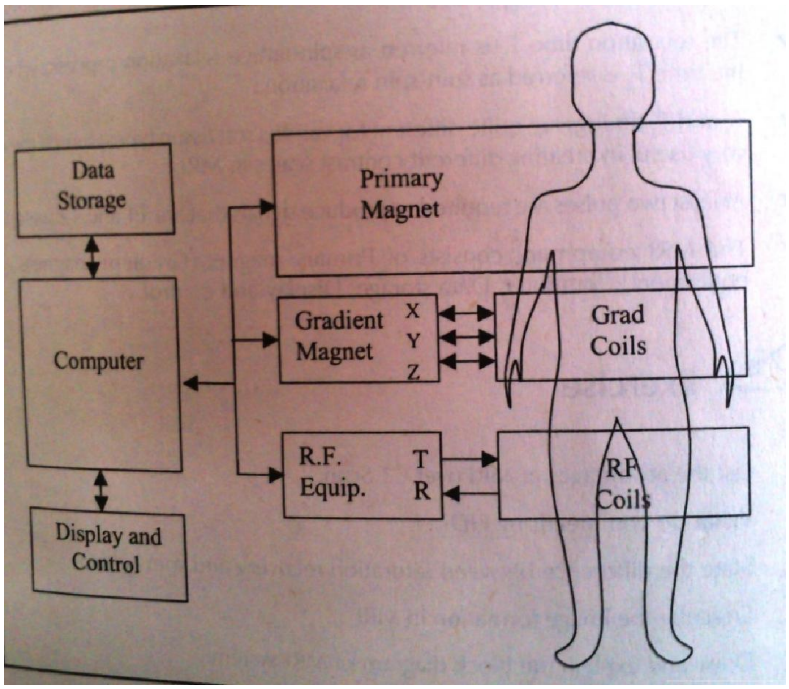


Fig :MRI scanner

Block diagram of MRI scanner consists 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 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 3 (12)

i)What is MRI . List any two types of magnets used in MRI.

(MRI -2m + types-2m) 4m

Ans:

MRI: Magnetic Resonance Imaging uses magnetic fields and radio frequency signals to obtain anatomical information about the human body as cross sectional images in any desired direction. It can easily discriminate between healthy and diseased tissue.

Types of magnets used in MRI :

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

2) Name the instruments used for the following applications and write their principle of working .4

1) Mammography

2) Examination of digestive tract

(instrument used-1m each + working-1m each)

Ans:

1)Instrument used for Mammography is X-ray machine.

-Principle of working **:**Mammography is anX-ray imaging procedure used for examination of female breast. It is primarily used for diagnosis of breast cancer and in guidance of needle biopsies. The X-ray tube with a small focal spot size is used. The film cassette has a single emulsion film and a single screen and is designed to provide excellent film contact. The units intended for film use have a molybdenum target X-ray tubes with a beryllium window and a 0.03 mm molybdenum filter. Radiographs are usually taken at 28-35 kV.

2) Instrument used for examination of digestive tract is Endoscopy.

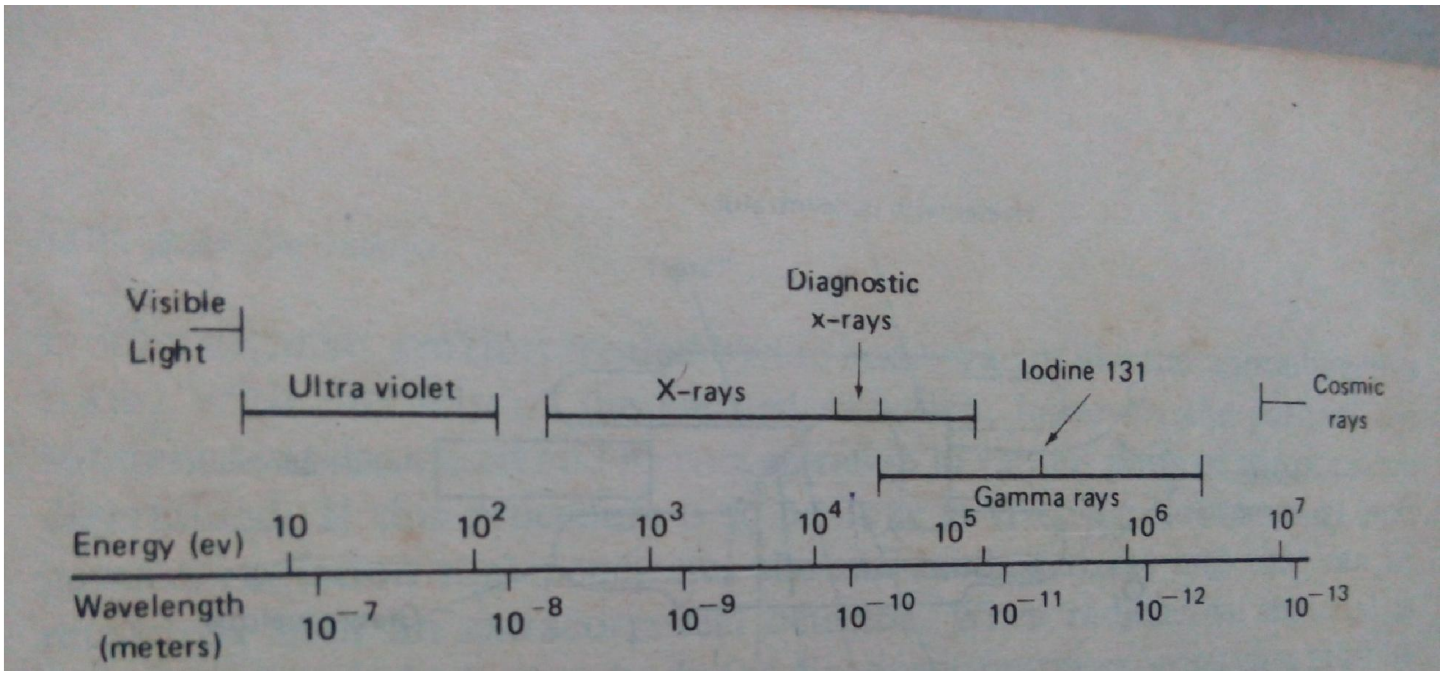
-Principle of working : Endoscopy is a procedure used to view internal body organs with the help of endoscope which is a specially designed hallow tube. Endoscope needs a way to enter into body organs via natural openings to get the image. Endoscopes such as Ophthalmoscope**,** Auriscope, Laryngoscope, Bronchoscope, Oesophagoscopes, Gastroscope, Thorancoscope, Cystoscope, Resectoscope, Sigmoidoscope are used according to their sight of use. CCTV is a one attachment facilitates to acquire images of internal body organs and monitor on television screen.

3) Draw a neat diagram of X-ray spectrum and explain it.

(diagram-2m + explanation-2m) 4m

Ans

Diagram :



Explanation: There are different types of radiation each with its own distinct properties such as Alpha rays, Beta rays, Gamma rays and X-rays. X-rays are electromagnetic radiation located at the low wavelength end of electromagnetic spectrum. X-rays have wavelength of the order 10^{-10} m. They propagate with the speed of $3x10^{10}$ cm/s and are unaffected by electric and magnetic fields. In X-rays wavelength is directly dependent on the voltage with which the radiation is produced. Because of short wavelength and extremely high energy, X-rays are able to penetrate through materials which readily absorb and reflect visible light. X-rays are absorbed when passing through the matter. X-rays are produced whenever electrons collide at very high speed with matter and are thus suddenly stopped. The energy possessed by the electrons appears from the site of collision as a parcel of energy in the form of highly penetrating electromagnetic waves (X-rays) of many different wavelengths, which together form a continuous spectrum.

4)Define the term installation and state the steps to be carried out for installation of angiography machine.

(definition-1m + steps-3m) 4m

Ans:

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 readyfor use.

Steps for Installation of angiography :

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 cart .

11. Check the settings ,inspect all the connection.

12. Perform demo test

(any other relevant ans should be consider as a valid ans)

Q. 4 b) Attempt any 1 (6)

1)What are the risk factors involved in X-ray machine . write stepwise procedure of installation of x-ray machine.

(risk factor-2m + steps-4m) 6m

Ans:

Risk factors involved in handling of x ray equipment are:

1. X rays are highly absorbed in soft tissue, and severe burns can result from exposure of the hands, arms, skin or eyes to the direct or diffracted beams.

2. High dose can cause reddening of the skin or erythema.

3. Loss of hair or epilation

4. If a large area of skin is irradiated, erythema and pigmentation will occur with the pigmentation eventually fading.

5. If enough radiation of the proper energy is absorbed in the skin this will result in permanent destruction of either hair or sweat glands, or whole skin, with a resulting scar.

6. It can cause chronic radiation dermatitis, Radiation cancer.

7. It can affect fetus if it is used for pregnant women.

While installing the x ray system we have to consider following steps

i) 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

ii) 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

iii) 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 properlygrounded.

iv) Different components of x ray machine

v) 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

(any other relevant answer should be consider as a valid answer)

2) What is the difference between fluoroscopy and radiography . State any four applications of fluoroscopy. 6m

Difference:

Parameter	Radiography	Fluoroscopy
Principle	In this the images are displayed on the X ray film by conventional method	In this technique the images are directly displayed on the CRT display or screen.
Specifications	Image intensifier is not required	Image intensifier is needed
Application	Detection of bone disorders and abnormalities	Continuous investigation of the body parts during surgery.
Advantage	Low cost, low power	Live images, less processing time, greater storage.

Applications:

i)Fluoroscopy is used in mobile surgical C-arms and in fixed systems for cardiac angiography, neuro angiography and interventional vascular radiography.

ii) Fluoroscopy can result in relatively high radiation doses to patients, especially for complex interventional procedures (such as placing stents or other devices inside the body), which require fluoroscopy be administered for a long period of time.

iii) Fluoroscopy used in Barium X-rays and enemas to view the gastrointestinal tract

iv) Fluoroscopy used in Catheter insertion and manipulation

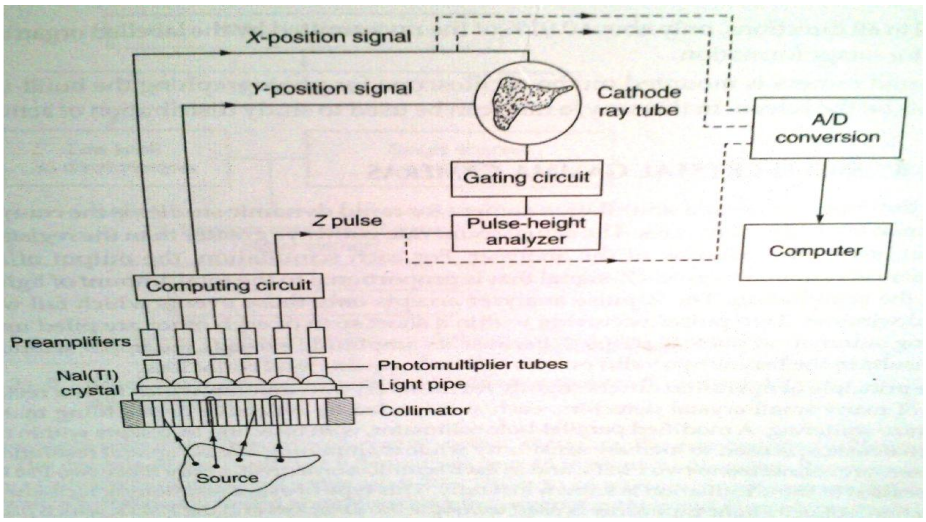
v) Fluoroscopy used in Placement of devices within the body, such as stents

vi) Fluoroscopy used in Angiograms

vii) Fluoroscopy used inOrthopaedic surgery

Q 5 Attempt any four of the following **16**

a)**Draw neat labelled diagram of Gamma camera and explain it**
Ans.:-



2

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 patients 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

2

b)List any four clinical applications of ultrasound **4**

Applications:

1) In ophthalmology it is used to measure axial length of the eye.
2) Use to determine the magnitude of the discontinuity
3)Take pictures of developing fetus
4)Break up kidney stones
5)To look at internal organs
6)To check blood flow.
7)The result of absorption of ultrasound in the tissue is due to the oscillation of particles about their mean position. This oscillations or sonic energy is converted into heat energy which is proportional to the intensity of ultrasound. This heat energy can be used for treatment in the following ways:

- Healing or thermal effect
- Micro-massage or mechanical effect
- Chemical and biological effect (wound healing)

c) Write any four biological effects of magnetic resonance imaging 4

Heating due to the rf power: Temperature increase produced in the head of NMR imaging would be about 0.3 degree centigrade

Static magnetic field:_No significant effects of the static field with the level used in NMR are known

Electric current induction due to rapid change in magnetic field

d) State advantages and disadvantages of x rays.(any 2 of each)

Ans :

Advantages of x-rays:
X-rays are used to treat malign tumors before its spreads throughout the human body.

- They help radiologists identify cracks, infections, injury, and abnormal bones.
- They also help in identifying bone cancer.
- X-rays help in locating alien objects inside the bones or around them. 2

Disadvantages of x-rays:

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

2

e) Write any four Medical Applications of X-rays **4**

Ans: **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 mordern 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.

f) List clinical applications of CT(any4) 4

Application of CT

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.
   (any other relevant ans should be consider as a valid ans)

Q 6 Attempt any four of the following 16

a)Why tungsten material is preferred as a target material in x ray tube? Name the other materials that can be used as a target materials 4

Ans:

Tungsten is chosen since it combines a high atomic number making it comparatively efficient in the production of x rays. It has high melting point enabling it to withstand the heavy thermal loads.

Other materials for that can be used as a target materials : Molybdenum

b) State and explain the terms

i)Working principle of CT machine

In the CT scan X ray source and detectors are mounted opposite each other in the rigid gantry. With the patient lying in the gantry between the X ray source and the detectors, measurements are made

by moving one or both of these around and across the relevant sections of the patient. CT scan is an image reconstructed from a large number of X ray absorption profiles taken at regular angular interval around a slice, each profile being made up from a parallel set of absorption values through the body. 2

ii) CT number:

Itisnormalized value of the calculated xray absorption coefficient of a pixel (picture element) ina comput ogram, expressed in Hounsfield units,

where the CT number of air is -1000and that of water is 0.

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

2

c) Enlist any four important technical specifications of ultrasound scanner 4

Specification:

1) Power supply – 230 V AC 50 Hz
2) Frequency range – 1 to 15 MHz
3) Scan time – 1 to 3 s
4) Eco signal intensity – up to 80 dB
5) Storage capacity - 512 Mb

d) Describe maintenance procedure of NMI machine 4

For those nuclear medicine instruments that "interface" directly with patients—the intraoperative probe, organ uptake probe, γ-camera, SPECT and SPECT/CT scanner, and PET and PET/CT scanner—safety features should be regularly inspected. Such features include manual emergency-off switches ("panic buttons"), collision-detection switches that immediately stop all motion if a collision occurs (e.g., between the rotating γ-camera detector and the patient during a SPECT acquisition), and interlocks that immediately turn off the x-ray tube of a SPECT/CT or PET/CT scanner if a primary-barrier door is opened during a CT scan.

All position displays on the gantry and computer console and all alignment lasers should likewise be visually inspected. All manual motion-control functions (e.g., gantry rotation, detector radial motion, and table translation) should be checked as well.

Finally, as with all electromechanical devices, intraoperative probes, organ uptake probes, γ-cameras, SPECT and SPECT/CT scanners, and PET and PET/CT scanners should be inspected regularly for frayed wires and broken or otherwise damaged electrical insulation, loose electrical or mechanical connections (including missing or visibly loose screws, nuts, or bolts), and dents, sharp edges, or other physical damage

e) **State any four properties of ultrasound. 4**

Ans:-

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.
Density- the more dense material, the more rapidly it transmits the sound.

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