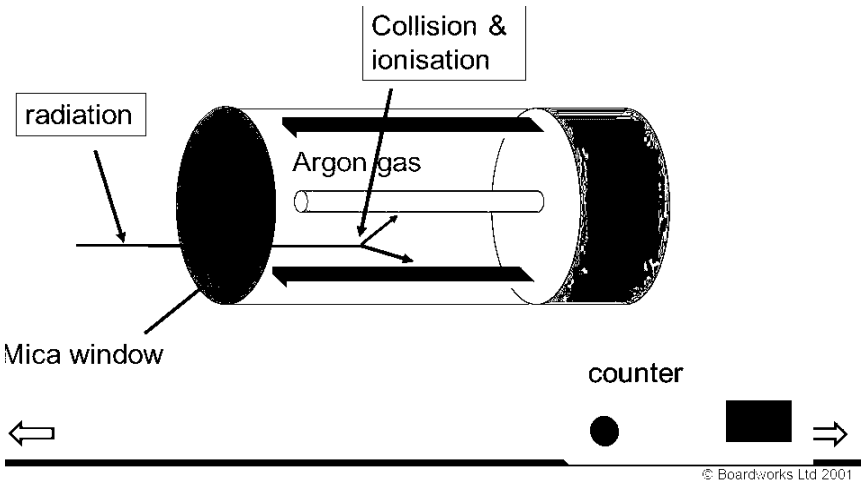
SUMMER – 2019 EXAMINATION

Subject Name: Medical Imaging Equipment **Model Answer** **Subject Code:** 17673

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. No.	Sub Q. N.	Answer	Marking Scheme
1.	a)	**Attempt any THREE of the following:**	12M
	(i)	**Draw Geiger Muller tube. Describe it.** **Ans:**  **Fig: Geiger Muller Tube** Geiger Muller tube is the sensing element of the Geiger counter instrument used for the detection of ionizing radiation. It detects a number of different radiation types. It is a gaseous ionization detector and uses the Townsend avalanche phenomenon to produce an easily detectable electronic pulse from as little as a single ionising event due to a radiation particle. It is used for the detection of gamma radiation, X-rays, and alpha and beta particles. It can also be adapted to detect neutrons. The tube operates in the "Geiger" region of ion pair generation. A G-M tube consists of a chamber filled with a gas mixture at a low pressure of about 0.1 atmospheres. The chamber contains two electrodes, between which there is a potential difference of several hundred volts. The walls of the tube are either metal or have their inside surface coated with a conducting material or a spiral wire to form the cathode, while the anode is a wire mounted axially in the centre of the chamber.	02M 02M

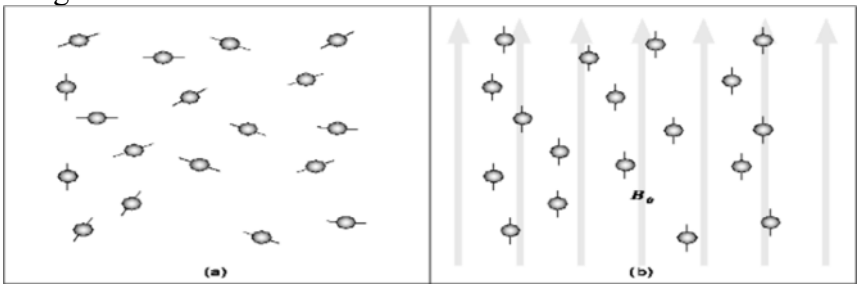
		When ionizing radiation strikes the tube, some molecules of the fill gas are ionized directly by the incident radiation, and if the tube cathode is an electrical conductor, such as stainless steel, indirectly by means of secondary electrons produced in the walls of the tube, which migrate into the gas. This creates positively charged ions and free electrons, known as ion pairs, in the gas. The strong electric field created by the voltage across the tube's electrodes accelerates the positive ions towards the cathode and the electrons towards the anode. Close to the anode in the "avalanche region" where the electric field strength rises exponentially as the anode is approached, free electrons gain sufficient energy to ionize additional gas molecules by collision and create a large number of electron avalanches. These spread along the anode and effectively throughout the avalanche region. This is the "gas multiplication" effect which gives the tube its key characteristic of being able to produce a significant output pulse from a single original ionising event.	
	(ii)	**Write steps in Installation of ultrasound machine.** **Ans:** **Installation procedure for ultrasound machine:** 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.	**04M**
	(iii)	**Write working principle of MRI.** **Ans:** The basis of MRI is the directional magnetic field, or moment, associated with charged particles in motion. Nuclei containing an odd number of protons and/or neutrons have a characteristic motion or *precession*. Because nuclei are charged particles, this precession produces a small magnetic moment. When a human body is placed in a large magnetic field, many of the free hydrogen nuclei align themselves with the direction of the magnetic field. The nuclei process about the magnetic field direction like gyroscopes. Where γ is the gyro magnetic ratio and B_0 is the strength of the applied magnetic field. The gyromagnetic ratio is a nuclei specific constant. For hydrogen, $\gamma = 42.6\text{MHz/Tesla}$ .To obtain an MR image of an object, the object is placed in a uniform magnetic field, B_0 , of between 0.5 to 1.5 Tesla. As a result, the object's hydrogen nuclei align with the magnetic field and create a net magnetic moment, M, parallel to B_0. This behaviour is illustrated in Figure below.  	

Figure: In the absence of a strong magnetic field, hydrogen nuclei are randomly aligned

(a) When the strong magnetic field, B_0, is applied, the hydrogen nuclei procedure about the direction of the field as in

(b) Next, a radio-frequency (RF) pulse, B_{rf}, is applied perpendicular to B_0. This pulse, with a frequency causes M to tilt away from B_0 as in Figure below

04M

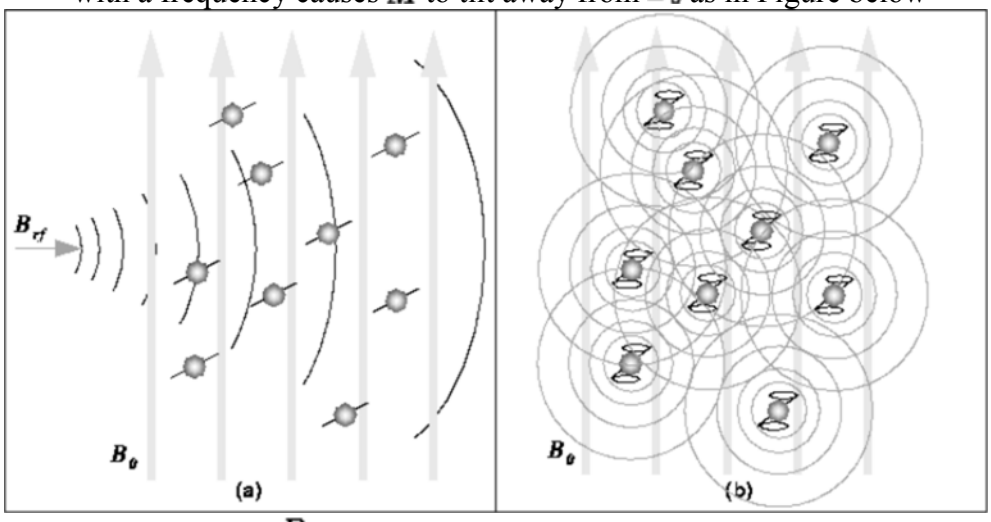


Figure: (a) The RF pulse, B_{rf}, causes the net magnetic moment of the nuclei, M, to tilt away from B_0.

(b) When the RF pulse stops, the nuclei return to equilibrium such that M is again parallel toB_0.

During realignment, the nuclei lose energy and a measurable RF signal

Once the RF signal is removed, the nuclei realign themselves such that their net magnetic moment, M, is again parallel with B_0. This return to equilibrium is referred to as relaxation. During relaxation, the nuclei lose energy by emitting their own RF signal (see above Figure b). This signal is referred to as the free-induction decay (FID) response signal. The FID response signal is measured by a conductive field coil placed around the object being imaged. This measurement is processed or *reconstructed* to obtain 3D grey-scale MR images.

(iv) **What are radio isotopes? Give its significance.**

Ans:

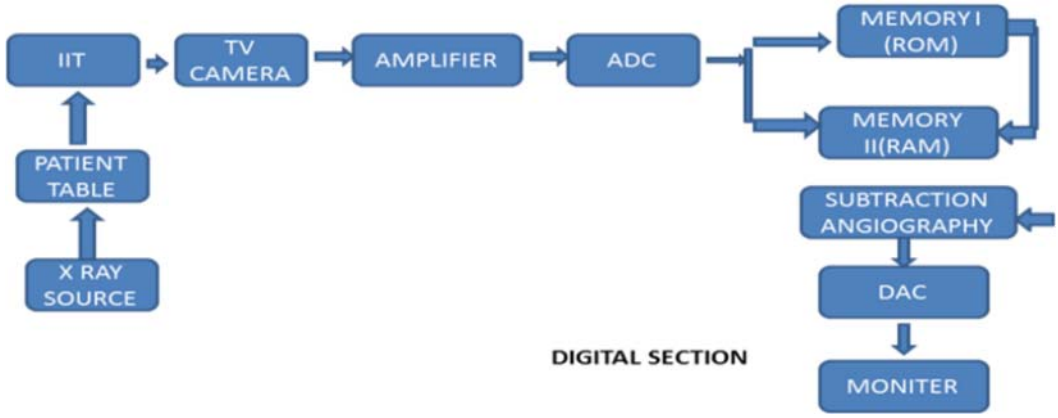
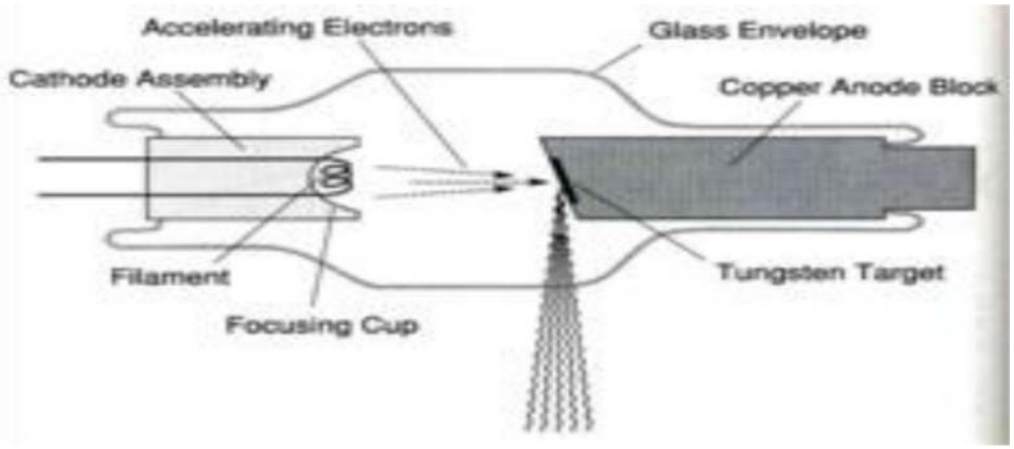
A radioactive isotope, also known as a radioisotope, radionuclide, or radioactive nuclide, is any of several species of the same chemical element with different masses whose nuclei are unstable and dissipate excess energy by spontaneously emitting radiation in the form of alpha, beta, and gamma rays. Every chemical element has one or more radioactive isotopes. For example, hydrogen, the lightest element, has three isotopes, which have mass numbers 1, 2, and 3.

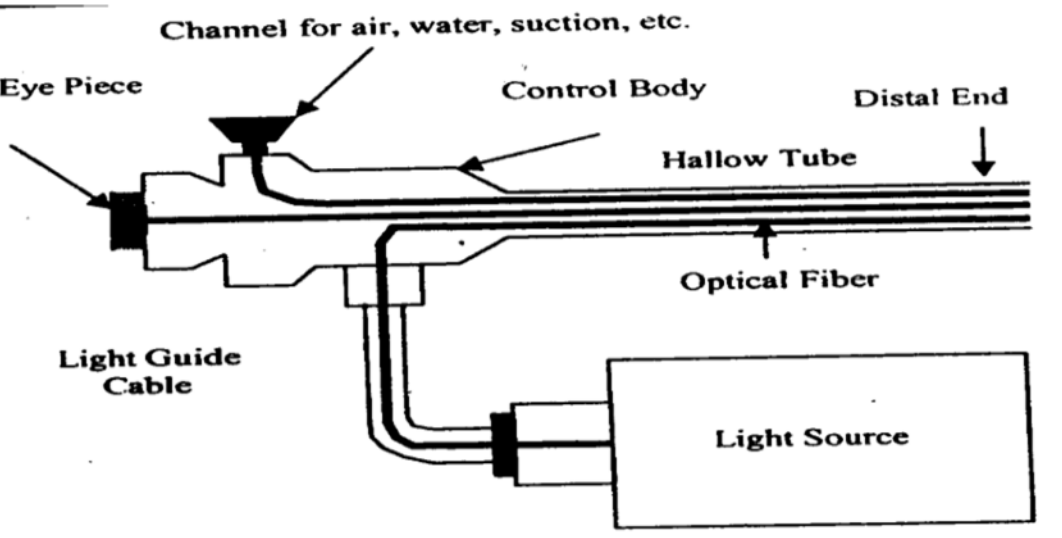
02M

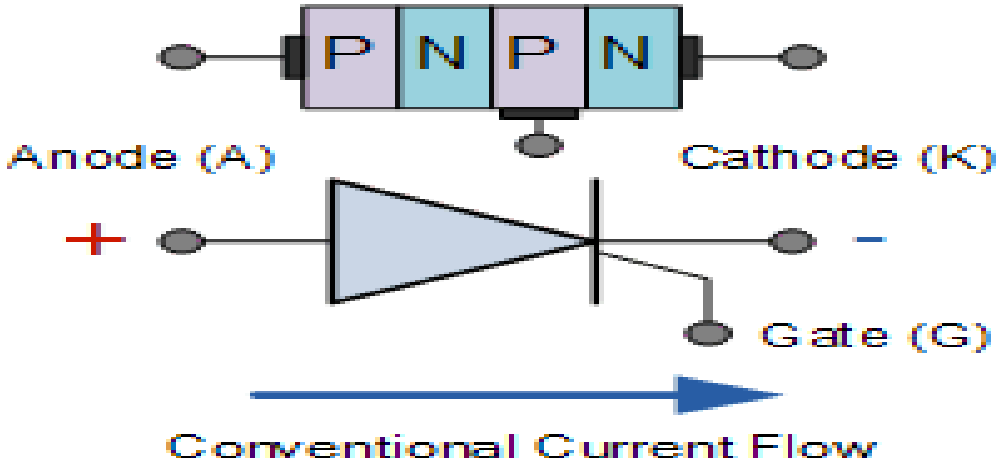
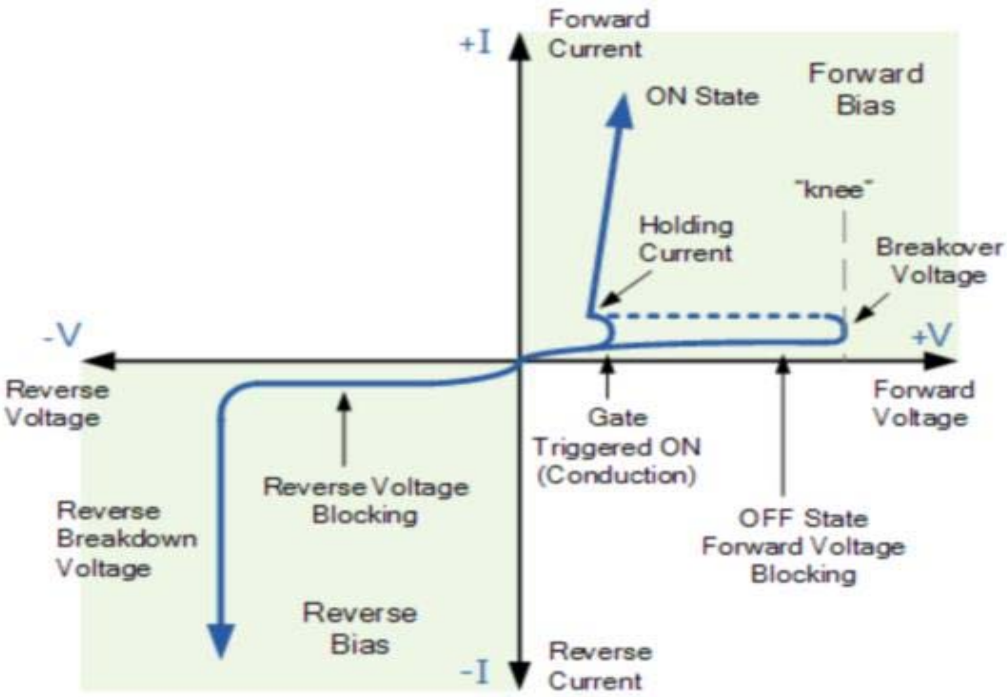
Significance of radio isotopes:

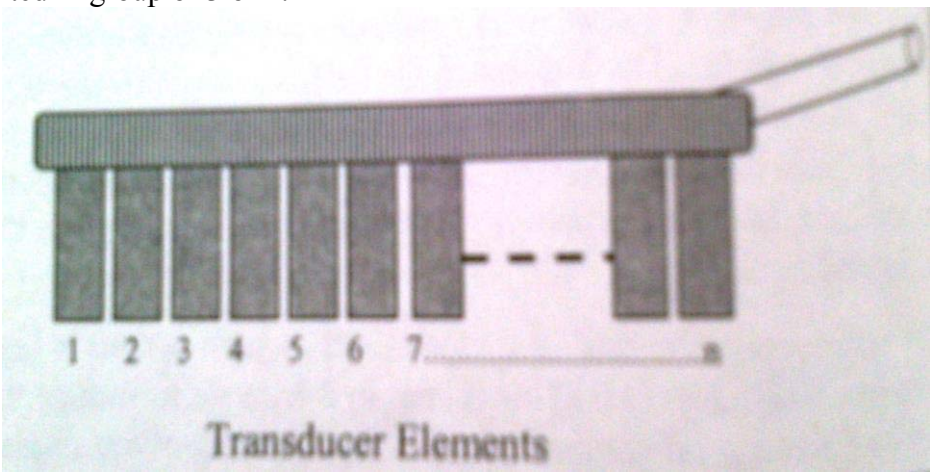
Radioisotopes have important uses in medical diagnosis, treatment, and research. Diagnostic techniques in nuclear medicine use radioactive tracers which emit gamma rays from within the body. These tracers are generally short- lived isotopes linked to chemical compounds which permit specific physiological processes to be scrutinized. They can be given by injection, inhalation or orally. The first type is where single photons are detected by a gamma camera which can view organs from many different angles. The camera builds up an image from the points from which radiation is emitted; this image is enhanced by a computer and viewed by a physician on a monitor for indications of abnormal conditions

02M

	b)	**Attempt any ONE of the following:**	**06M**
	(i)	**Draw diagram of angiography machine and describe it.** **Ans:**  **Fig: Angiography machine** 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 an invasive method that helps the physician to diagnose & treat the medical condition. **X ray source:** It is used to pass narrow x ray beam to the patient. **Patient table:** patient is lie on table. **IIT:** The reflected x rays are collected by IIT unit in which brightness of image is increased & output is displayed on fluorescent screen. **Amplifier:** It amplifies the output of image intensifier tube and gives it to the ADC where signal is converted into digital form. **Memory I & II:** digitally converted signal is stored into the ram & rom memory. **Subtraction angiography:** to get a new image subtraction angiography is used to the analog signal on the monitor for which DAC is used. **DAC:** it converts digital signal into analog signal. **Monitor:** by using TV camera unit +we can see the clear & live image of a patient body on monitor.	**03M** **03M**
	(ii)	**List the limitations of stationary anode x-ray tube? Draw stationary anode tube. Write materials used as target and filament.** **Ans:**  **Fig: Stationary anode tube**	**02M**

		Limitations of stationary anode x-ray tube: Anode stays still (stationary) and All that energy coming to the anode from the cathode produces a huge amount of heat. If that heat keeps hitting the same spot over and over again, as in a stationary anode tube, eventually the surface of the anode can deform and the angle of the X-ray beam will shift, reducing dose efficiency and the overall image quality the tube is capable of producing. **Materials used as target and filament:** The anode is a small metal disc (usually made of tungsten or copper) and the filament is made of tungsten.	**02M** **02M**
2.		**Attempt any <u>FOUR</u> of the following:**	**16M**
	a)	**Write four medical applications of CT.** **Ans:** 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. 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. 3. It is used in the diagnosis of aneurysms (bulging), stenosis (narrowing) of the arteries, dissection of the aorta etc. 4. CT scan is 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.	**04M**
	b)	**Write four properties of ultrasound.** **Ans:** 1. Ultrasounds frequency is 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.	**04M**
	c)	**Draw block diagram of Endoscopy machine.** **Ans:**  **Fig: Block diagram of Endoscopy Machine**	**04M**

	d)	**Draw symbol and construction of SCR, Draw V-I characteristics of it.** **Ans:**  **Fig: Construction and symbol of SCR**  **Fig: V-I Characteristics of SCR**	**01M** **01M** **02M**
	e)	**State the steps carried out in installation of Angiography machine.** **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	**04M**

		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.	
	f)	**Enlist the risks involved in handling MRI machine.** **Ans:** **Risks involved in handling MRI machine:** Risk factors involved in handling 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.	**04M**
3.		**Attempt any <u>FOUR</u> of the following:**	**16M**
	a)	**Draw and describe Linear and phased array.** **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** **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** **Multiple Element Phased Array:** The multiple element Phased Arrays consists of around 5 tiny crystals. In these 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.	**01M** **01M** **01M**

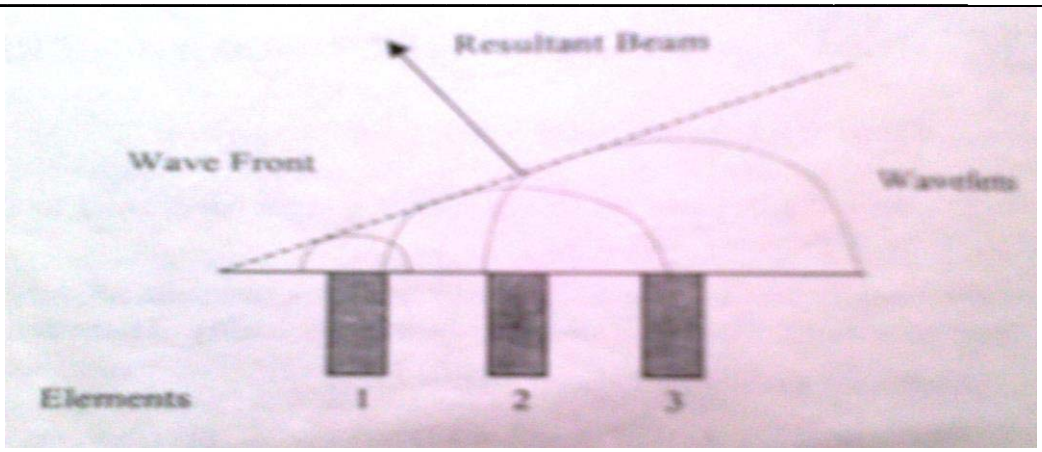
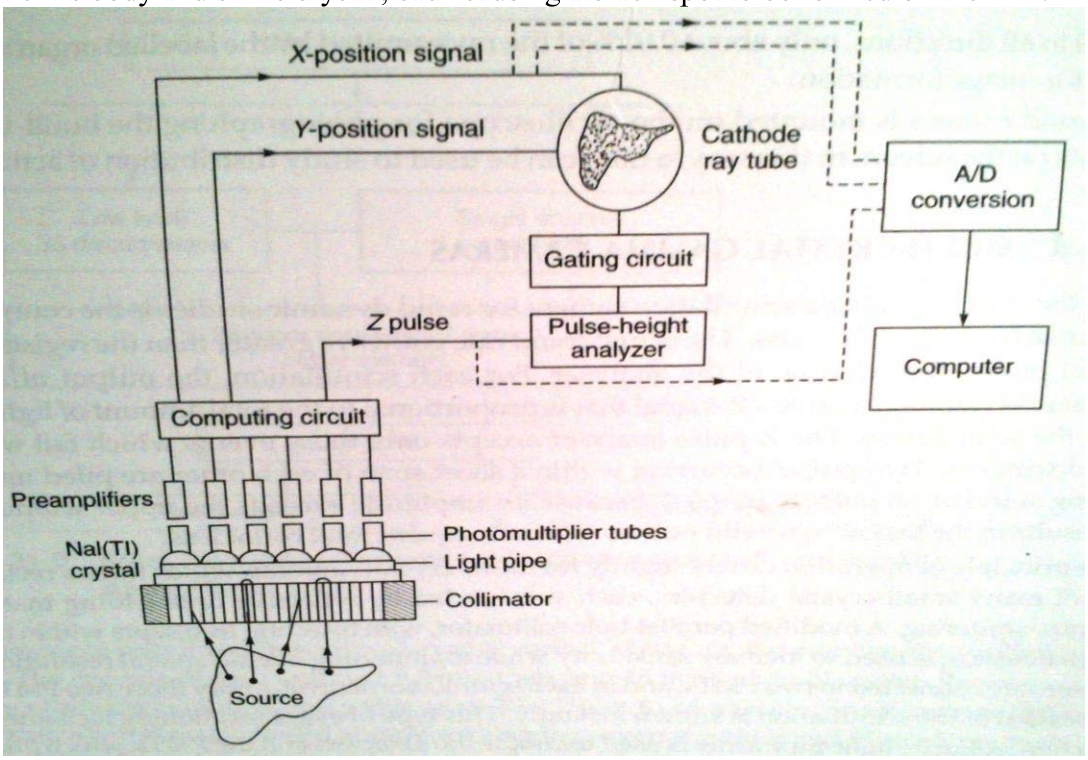
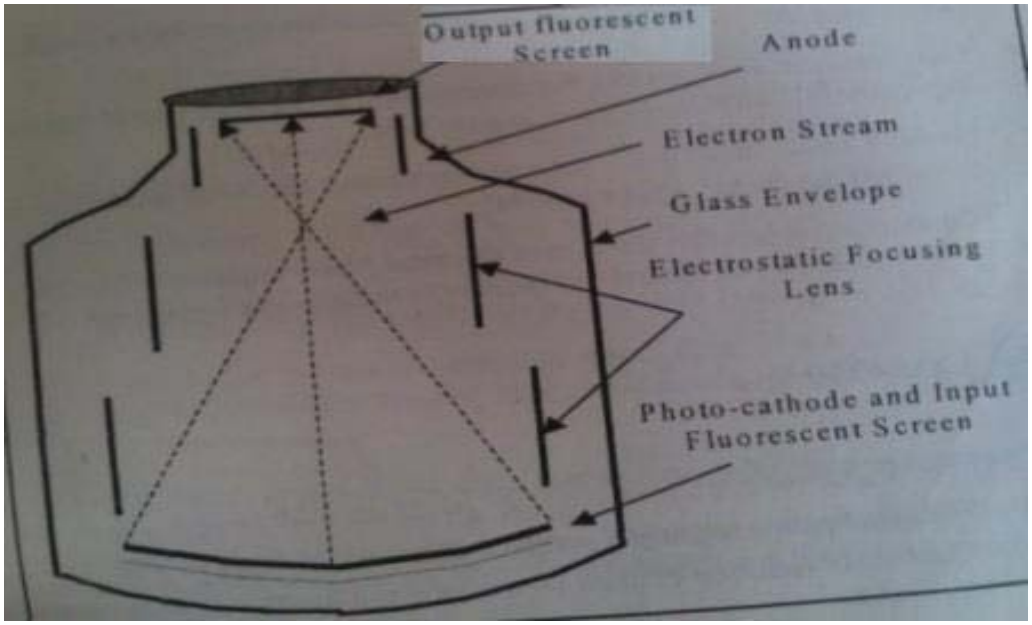
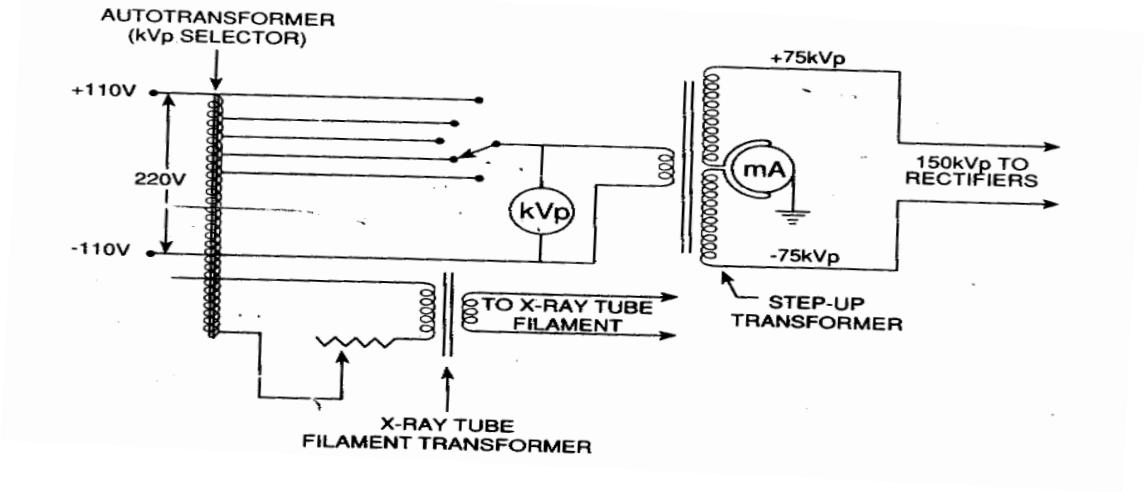
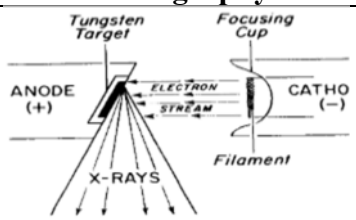
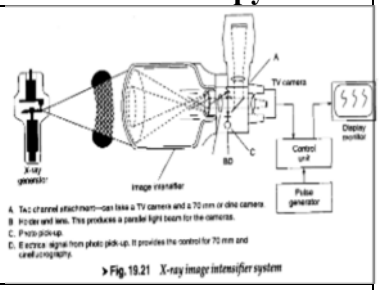
		 **Fig: Multiple element phased array**	**01M**
	b)	**Draw and describe Gamma camera.** **Ans:** The gamma camera is a stationary imaging device as opposed to the rectilinear scanner in which the detector is made to move over the organ of interest. It consists of following functional components Detector: This consists of a collimator, crystal, photomultiplier tubes and 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.  **Fig: Gamma Camera**	**02M** **02M**
	c)	**Draw and describe image intensifier tube.** **Ans:** 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 these additional energy atoms gets excited. Excited atoms further gives up the surplus energy as visible light photons. These light photons strike 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 carries the fluoroscopic image to the observer.	**02M**
		 **Fig: Image intensifier tube**	**02M**
	d)	**Write steps in installation of x-ray machine.** **Ans:** **Installation steps of x-ray machine:** 1. The basic radiological system designed by world health organization. For x ray laboratory minimum two rooms are required i.e. x ray tube and dark room. The BRS has also specified 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 1) For manual processing the dark room should have floor area of 5m 2) For automatic processing the dark room should have floor area small dimensions. 3) The dark room must have entirely light proof arrangement even with the bright sunlight. 4) 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.	**04M**
	e)	**Describe the types of magnets used in MRI.** **Ans:**	

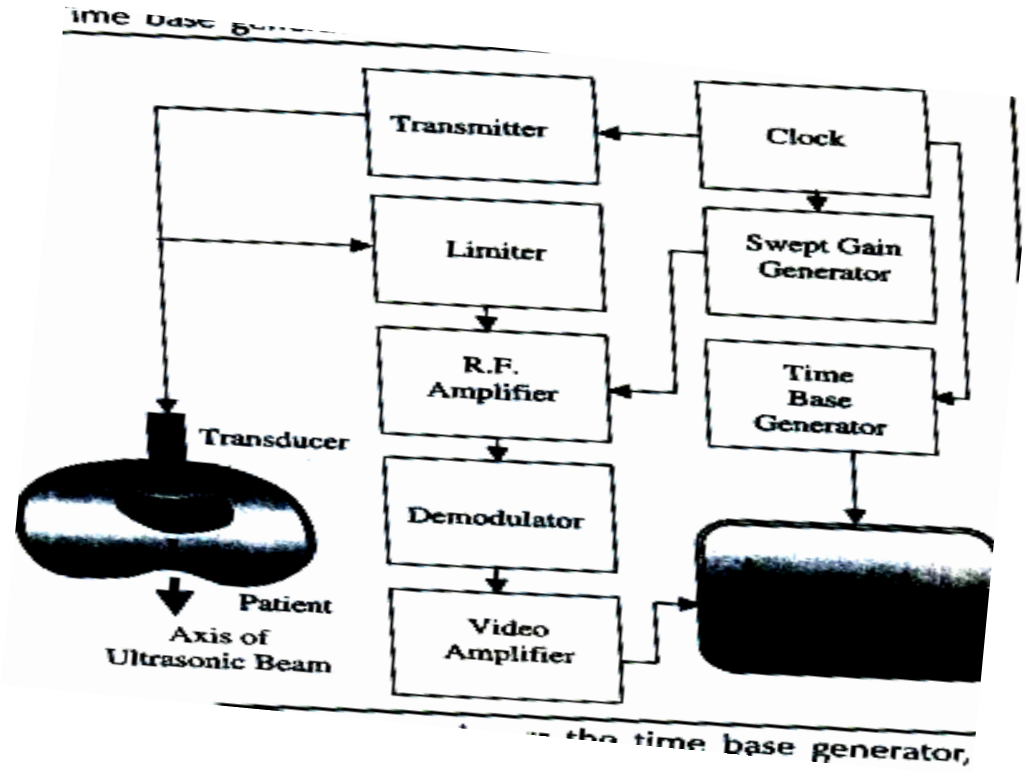
		Types of magnets used in MRI: **1.** Resistive magnets are made from many coils of wire wrapped around a cylinder through which an electric current is passed. This generates a magnetic field. When the electricity is shut off, the magnetic field dies. These magnets are lower in cost to make than a superconducting magnet (see below), but need huge amounts of electricity to operate because of the natural resistance of the wire. The electricity can get expensive when higher power magnets are needed. 2. Electromagnets make use of soft magnetic materials such as pole faces which become magnetized only when electric current is passed through coils wound around them. Electromagnets obviously require external electrical power supply. 3. A permanent magnet is just that -- permanent. The magnetic field is always there and always at full strength. Therefore, it costs nothing to maintain the field. A major drawback is that these magnets are extremely heavy: sometimes many, many tons. Some strong fields would need magnets so heavy they would be difficult to construct. 4. Superconducting magnets are by far the most commonly used in MRIs. Superconducting magnets are somewhat similar to resistive magnets - coils of wire with a passing electrical current create the magnetic field. The important difference is that in a superconducting magnet the wire is continually bathed in liquid helium (at a cold 452.4 degrees below zero). This almost unimaginable cold drops the wire's resistance to zero, dramatically reducing the electricity requirement for the system and making it much more economical to operate.	**04M**
4.	**a)**	**Attempt any <u>THREE</u> of the following:**	**12M**
	(i)	**Describe the term RF shielding and shimming in MRI machine.** **Ans:** **RF shielding:** RF shielding for MRI rooms is necessary to prevent noise of radio frequency from entering into the MRI scanner and distorting the image. The three main types of shielding used for MRIs are copper, steel, and aluminum. Copper is generally considered the best shielding for MRI rooms **Shimming:** In passive shimming small pieces of sheet metal or ferromagnetic pellets are affixed at various locations within the scanner bore to improve homogeneity. Conversely, active shimming uses currents directed through specialized coils to generate a "corrective" magnetic field.	**02M** **02M**
	(ii)	**Describe maintenance procedure of thermography machine.** **Ans:** **Maintenance procedure of thermography machine:** 1. Check all electrical connections. 2. Check for any loose connections. 3. Clean lenses of IR Cameras. 4. Check image quality. 5. Carry out calibration procedures 6. General maintenance procedure for computer system.	**04M**
	(iii)	**Draw and describe HV (High Voltage) circuit in X-ray machine.** **Ans:** 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	**02M**

		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  **Fig: High voltage control circuit**	**02M**
	(iv)	**Write steps in maintenance of angiography machine.** **Ans:** **maintenance steps 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: Personal computer where the Windows 95 / 98 has been installed. 5. 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. 6. Check calibration for motor of arm 7. Check calibration of position table for its up down movement. 8. Check collimator alignment and its position. 9. Check x ray tube alignment & its position. 10. Check shutter & filter calibration. 11. Check battery & maintain cover. 12. Update software periodically. 13. Check TV camera connections, IIT, XRAY TUBE	**04M**
	b)	**Attempt any <u>ONE</u> of the following:**	**06M**
	(i)	**Write risks involved in handling X-ray machine.** **Ans:** **Risk involved in handling of x ray machine 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.	**06M**

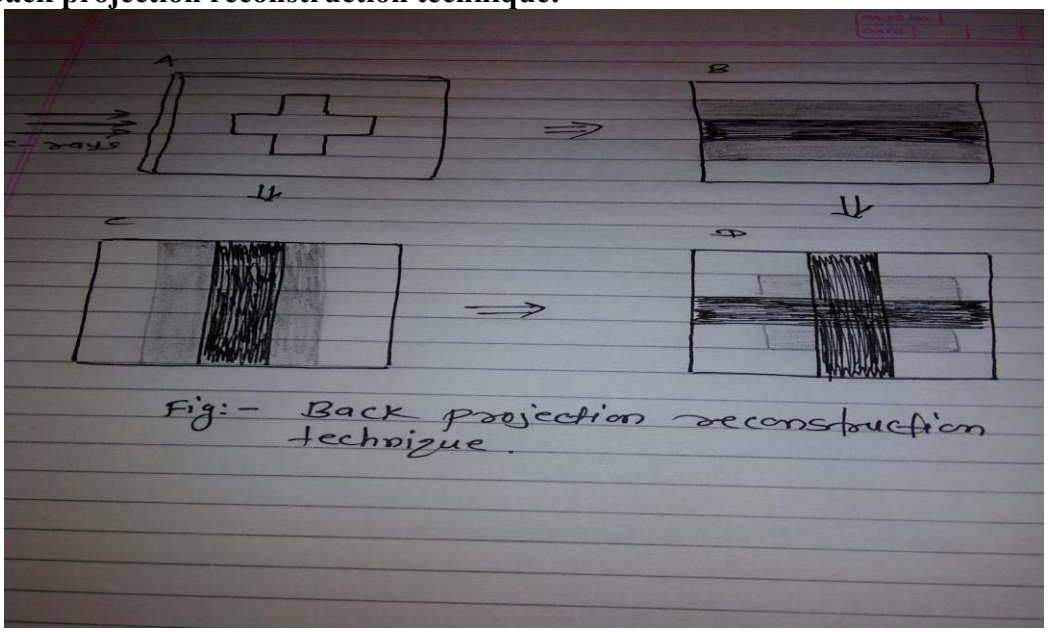
		6. It can cause chronic radiation dermatitis, Radiation cancer. 7. It can affect fetus if it is used for pregnant women.	
	(ii)	**Differentiate between Fluoroscopy and Radiography on the basis of 1) Diagram 2) Principle 3) Applications 4) Viewing media 5) Advantages 6) Disadvantages (01 mark each).** **Ans:**	**06M**

Parameters	Radiography	Fluoroscopy
Diagram	 **Figure 2–4** Lateral view of the cathode and anode of a stationary anode x-ray tube	 Fig. 19.21 X-ray image intensifier system
Principle	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.	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.
Viewing media used	Radiographic film	TV Camera
Advantages	**1.**Accurate Diagnosis **2.**Nondestructive **3.**Pictorial Presentation of Information **4.**Portable **5.**Versatile Applications	**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	**1.** Very small increased risk of cancer in future from exposure to ionizing radiation (x-rays). Risk is greater for children	**1.** Although radiation is minimal, there is the chance of skin injury due to radiation exposure, as well as the usual risks associated with radiation. **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.	
		Applications	**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. Thermography:** 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.	**1.**To obtain real-time moving images of the internal structures of a patient **2.** Investigations of the gastrointestinal tract, including barium enemas, defecating photograms, 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.	

		Table: Difference between Fluoroscopy and Radiography	
5.		**Attempt any <u>FOUR</u> of the following:**	**16M**
	a)	**Describe maintenance procedure of NMI machine.** **Ans:** 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.	**04M**
	b)	**Draw and describe A-scan machine.**  **Fig: A-Scan machine** 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	**02M**

		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 and 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 into corresponding ultrasound pulses by piezoelectric crystal acting as transducer and injected into patient body. Echoes of ultrasound are converted into electrical, signal by the same transducer. Then these signals are amplified suitably by a RF amplifier. The swept gain generator increases 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.	**02M**
	c)	**Enlist biological effect of MRI.** **Ans:** **Biological effects/hazards of MRI:** 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	**04M**
	d)	**State installation procedure of x-ray machine.** **Ans:** **Installation procedure of x-ray machine:** 1. The basic radiological system designed by world health organization. For x ray laboratory minimum two rooms are required i.e. x ray tube and dark room. The BRS has also specified 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 1).For manual processing the dark room should have floor area of 5m 2)For automatic processing the dark room should have floor area small dimensions.3)The dark room must have entirely light proof arrangement even with the bright sunlight.4)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.	**04M**
	e)	**Write two advantages and disadvantages of x-ray machine.** **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.	**02M**

		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.	**02M**
	f)	**Name image reconstruction techniques in CT. Describe any one.** **Ans:** **Image reconstruction techniques in CT:** 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:**  **Fig: Back projection reconstruction technique** Back projection sometimes 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 produces a crude reproduction of the original object. **2. 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.	**02M** **02M**

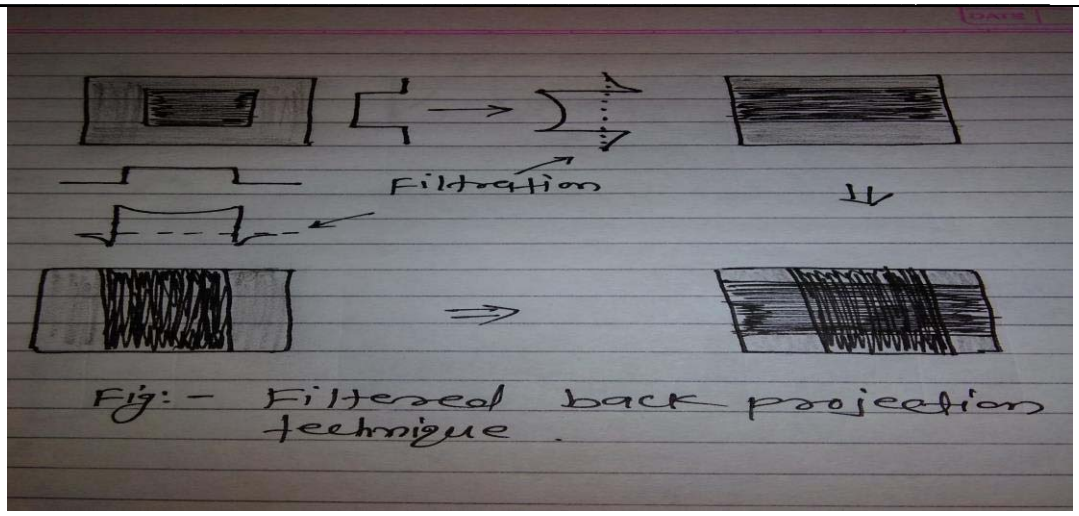


Fig: Filtered back projection technique

3. 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 elements 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.

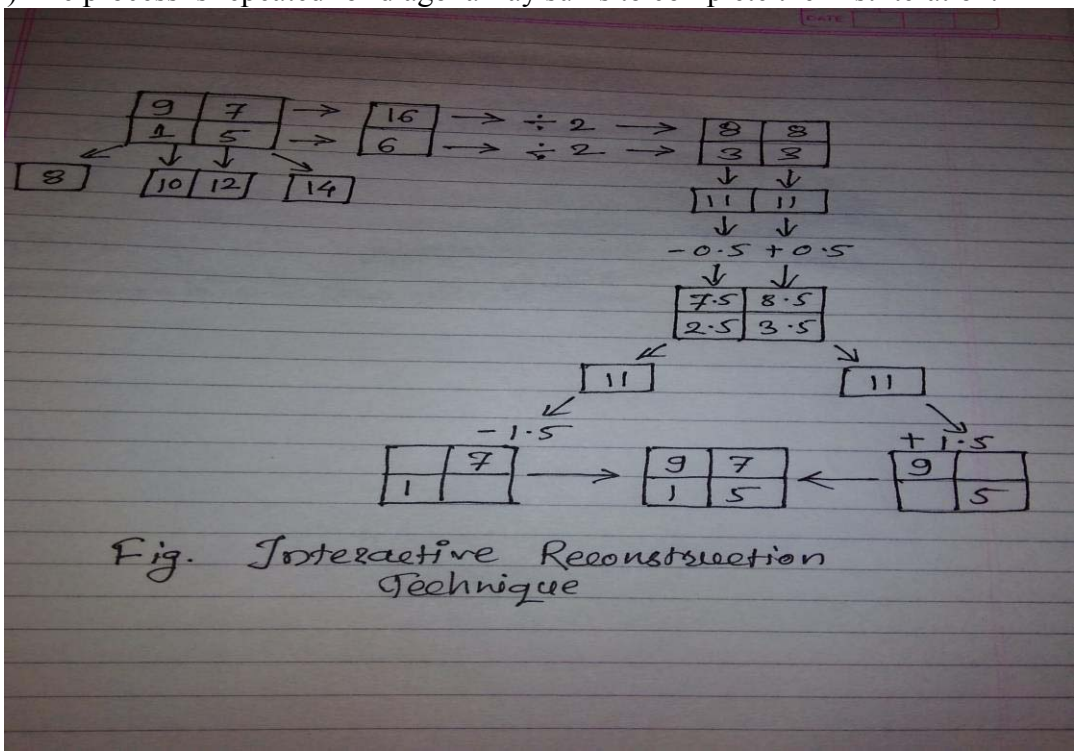
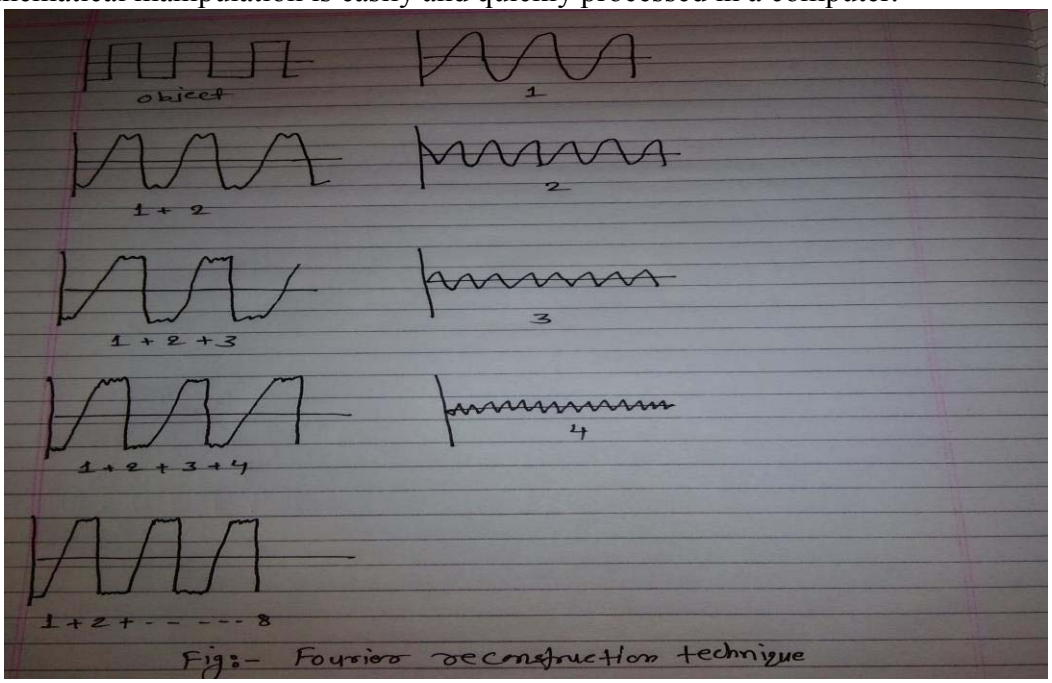
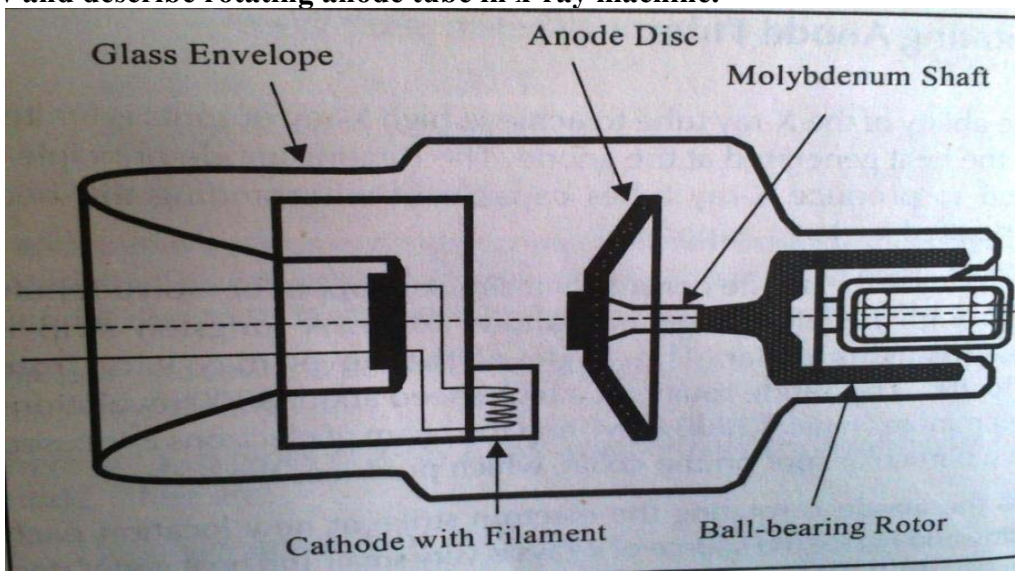
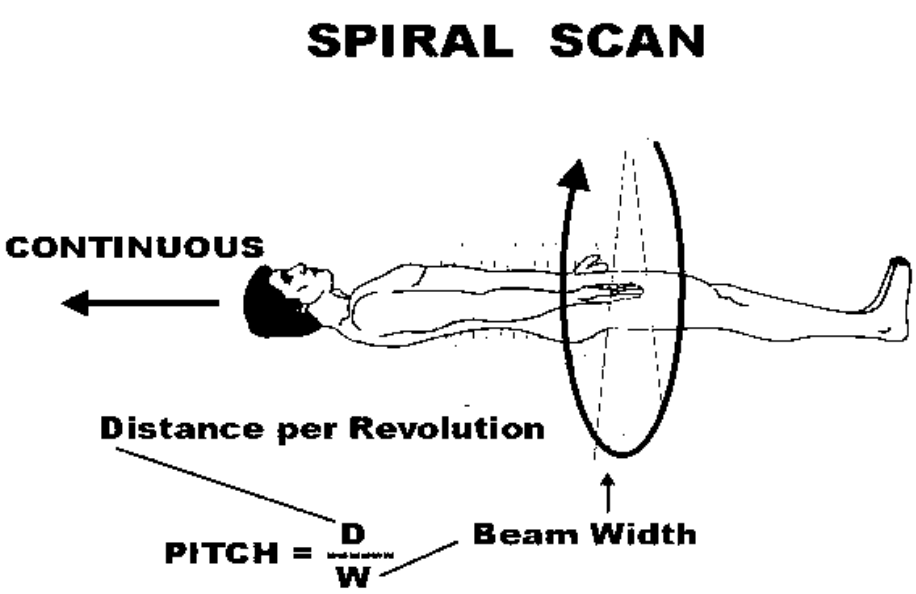
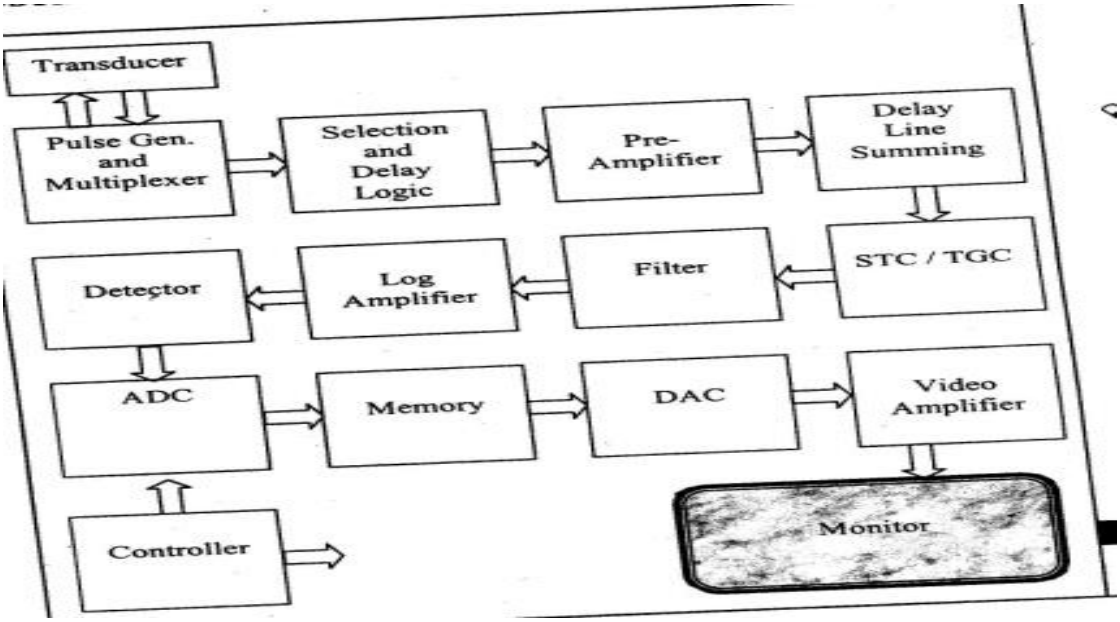


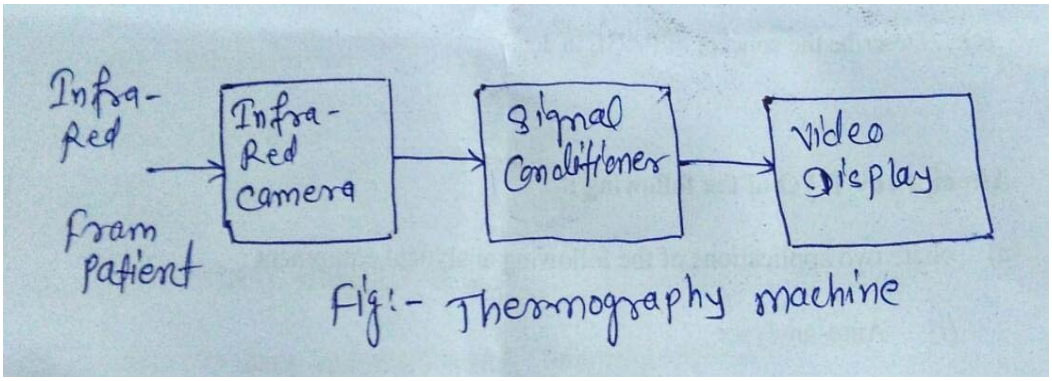
Fig: Iterative reconstruction technique

4. 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.  **Fig: Fourier reconstruction technique**	
6.		**Attempt any <u>FOUR</u> of the following:**	**16M**
	a)	**Draw and describe rotating anode tube in x-ray machine.**  **Fig: Rotating anode tube** During operation, a large disk-shaped tungsten anode is rotated at high speed (3000 to 9000 revolutions per minute). The motive force for the rotation is provided by an induction motor the windings of which are housed outside the tube. Although the focal spot of the electrons impinging on the anode is no larger than that in a tube with a stationary anode, the effective area of the anode exposed to the beam is much larger. By this means, the heating of the anode is reduced and the tube loading can be increased (e.g., up to 500 mA with a 2 mm x 2 mm focal spot).	**02M** **02M**

	b)	**Describe spiral CT scan with diagram.**  **Fig: Spiral CT** Spiral computed tomography, or helical computed tomography, is a computed tomography (CT) technology in which the source and detector travel along a helical path relative to the object. Typical implementations involve moving the patient couch through the bore of the scanner whilst the gantry rotates. Spiral CT can achieve improved image resolution for a given radiation dose, compared to individual slice acquisition. Most modern hospitals currently use spiral CT scanners.	**02M** **02M**
	c)	**Draw and describe B scan machine.**  **Fig: B scan machine** 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 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 up to this stage signal is processed according to the depth of interest by sensitivity time control. To obtain an image of good	**02M** **02M**

		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.	
	d)	**Draw block diagram of thermography machine and describe it.** **Ans:**  **Fig: Block diagram of thermography machine** Infrared 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 an 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.	**02M** **02M**
	e)	**State maintenance procedure in ultrasound machine.** **Ans:** **Maintenance procedure in 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.	**04M**