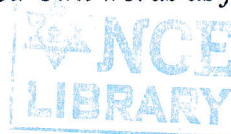


TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Bhadra

Exam.	Regular	
Level	BE	Full Marks 80
Programme	BCT, BEI	Pass Marks 32
Year / Part	IV / I	Time 3 hrs.

Subject: - Biomedical Instrumentation (Elective I) (EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.



1. What is biomedical instrumentation? List the various applications of the biomedical instruments. Draw and describe about man-instrument system. [1+3+2+2]
2. What is bioelectric signal? List the various types of medical electrodes. Draw the equivalent circuit of single and double electrodes. Describe about the construction of microelectrode. [1+2+2+3]
3. What is transducer? Discuss about the functionality of piezo-electric transducer. Which class of transducer is called the active and passive transducer? [2+4+2]
4. Discuss about the functionality of ECG along with neat diagram. [8]
5. Why the artificial kidney is needed? Discuss about operation of SAW-Lithotripter machine. [2+6]
6. With the neat diagram, explain about the blood pressure measurement. [8]
7. Write down the medical applications of X-ray. Discuss about the operation of the MRI Imaging technique. [3+5]
8. What tele-metering? List the types of tele-metering techniques. Discuss about the use of telemedicine through the mobile communications system. [2+1+5]
9. Write short notes on: (Any Two) [2×8]
 - a) Micro and macro electric shock
 - b) Safety measure and leakage current
 - c) Operation of EEG

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2081 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCT, BEX	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (Elective I) (EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



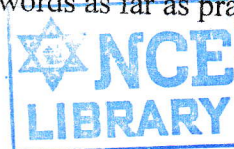
1. a) What is Cardiac Output? How is it calculated? Explain the circuit diagram of the DC Defibrillator Machine with consideration of patient and physician's safety. [6]
- b) What is the basis of the generation of ultrasound waves? What are the differences between A- Mode and B-Mode display formats based on their applications? [6]
- c) What is Electrode Theory? Design equivalent circuits of electrode and transducer and explain their output performances. [4]
2. a) What are the operating principles of Electromagnetic and Ultrasonic Blood Flowmeters? What is Video Angiography? Explain with a suitable diagram. [6]
- b) What is a Wireless Telemetry System? How is Telemedicine useful in saving patient's life using computers and communications equipment? Describe with an example. [6]
- c) What are the Ten Design Consideration factors in designing a man-instrument system? Design a simple man-instrument system and describe its components. [4]
3. a) What is Computer Tomography? What are the four major sub-systems of the CT-Scan Machine? How does the scanning system of CT-Scan help to acquire information to reconstruct a picture for an accurate diagnosis? Describe with a complete diagram. [8]
- b) What are the physiological effects of electricity? Design a complete circuit diagram with good grounding. How leakage current will flow through the Heart patient and safely to the ground if a low-value of ground resistance is available? Assume 100 μ A leakage current and 500 Ohms patient resistance. [8]
4. a) How transmitter is triggered by a pulse repetition frequency generator to generate large amplitude of pulses from the transducer and utilize them to view images on the display monitor in the Basic Pulse Echo Apparatus? [8]
- b) What is a Dialyzer? Why is it called an artificial kidney? Explain. [4]
- c) What is EMG? Explain its recording technique. [4]
5. a) Design a micro-processor-based ECG Machine and explain its lead selection and a video display. Draw the connection diagram of three augmented Unipolar limb leads. [8]
- b) Write short notes on: [2×4]
 - i) ESWL Based on the Electro-hydraulic method
 - ii) Image detection system of MRI System

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Bhadra

Exam.	Regular	
Level	BE	Full Marks 80
Programme	BEX, BCT	Pass Marks 32
Year / Part	IV / I	Time 3 hrs.

Subject: - Biomedical Instrumentation (EX72503) (Elective I)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



1. a) What is biomedical engineering? Draw the Man-Instrument system and briefly describe about it. [2+3+3]
b) Define bio-electric potential. List the types and examples of bio-electric potential. Describe about the action potential. [2+2+4]
2. a) What is ECG? Show the ECG lead configuration and describe about the recording scheme. [1+4+3]
b) Draw the block diagram of the EEG and describe about its operation. [4+4]
3. a) Draw the block diagram of the MRI-Machine and explain about its operation. [4+4]
b) What are non-Invasive diagnostic instruments? Discuss about the magnetic blood flow meter. [2+6]
4. a) Show the functional units of hemodialysis machine and write its operation. [5+3]
b) What is telemedicine? Discuss about the tele-medicine using the mobile communication. [2+6]
5. Write short notes on: (Any Four) [4×4]
 - a) Performance parameters of transducers
 - b) Lithotripter machine
 - c) Micro-shocks and Macro-shocks
 - d) Leakage current and prevention
 - e) Single channel telemetry

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (EX72503) (Elective I)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



1. a) How would you relate man-instrument system with wireless telemetry system? Design a multi-channel wireless telemetry system to transmit ECG and HR signals of a patient. How this system fulfills the basic objectives of man-instrument system? What are the ten design considerations factors of medical instrumentation system? [8]
- b) What is EEG and Evoked potentials? Design an instrumentation amplifier to record these signals. Explain practical EEG recorder. Compare EEG signals with ECG signals. [8]
2. a) What is ventricular fibrillation? Draw an ECG waveform for this indication. How can DC defibrillator machine restore normal cardiac rhythm without affecting the patient's and physician's safety? Design connection diagram of three limb leads and three unipolar augmented limb leads of ECG recording configuration. [8]
- b) What are the operating principles of ultrasonic blood flow meter and Electromagnetic blood flow meter? Describe an ultrasonic blood flow meter with suitable schematic diagram. [8]
3. a) What are the physiological effects of electricity? How are sources of noise levels reduced? Draw a proper grounding circuit to minimize noise produced by signal sources. What are the differences between micro shocks and macro shocks? [8]
- b) How the capacitive properties of the piezo-electric transducer affect the response of the transducer? What are the differences between electrodes and transducers? Describe some important applications of electrodes and transducers in the medical field. [8]
4. a) What are the operating principles of CT and MRI? Explain the detection system of MRI. Compare CT and MRI. [8]
- b) What is an artificial kidney? Draw a schematic diagram of Lithotripter machine and explain its function briefly. [8]
5. Write short notes on: [4×4]
 - a) Resting and Action Potentials
 - b) EMG Recording technique
 - c) PC based ECG design
 - d) Differences between X-RAY and US machine

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (Elective I)(EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.



1. a) What is Bio-Instrumentation? Describe the objectives of MAN instrumentation system. Explain the system characteristics for a biomedical instrumentation system with reference to ECG. [8]
- b) Why cell membrane polarized at rest? Describe ECG waveforms. Explain piezoelectric transducer with its principle and diagrams. [8]
2. a) What are the different types of Blood flow meter? Why blood flow meter is necessary in biomedical instrumentation? Explain the Ultrasonic Blood flow meter with its operation. [8]
- b) What is Steady State visual evoked potential? Explain the different stages of sleep with respective EEG pattern and frequency rhythm. [8]
3. a) Explain the working of X ray Machine with its functional diagram. Describe the effects and application of X ray in different areas. [8]
- b) Compare and contrast CT-scan machine and ultrasound. Explain magnetic resonance imaging system with its principle and working procedures. [8]
4. a) Describe the types of dialyzers in hemodialysis procedure. Explain the lithotripter machine lithotripsy working principle and procedure. [8]
- b) Describe the elements in telemetry system. Explain the single channel radio telemetry system with single channel FM transmitter. [8]
5. Write short notes on: [4×4]
 - a) Defibrillator machine
 - b) Ultrasound machine
 - c) Types of biopotential electrodes
 - d) Leakage current and its types

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (Elective I)(EX 72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.



1. a) What do you mean by Biometrics? Describe the specific characteristics of Biomedical Instrumentation System. Explain man instrumentation system with diagram. [8]
 - b) Why is cell membrane polarized at rest? Explain the physiological nature of ECG waveform. Describe the blood flow mechanism in human body. [8]
2. a) Differentiate active and passive transducer. What are the transducers used for Biomedical instrumentation? Explain the piezoelectric transducer with waveform. [8]
 - b) Explain three bipolar limb lead and three unipolar limb leads with reference to 12 leads ECG electrode configuration. Describe the procedure for ECG recording and measurement. [8]
3. a) List the benefits and uses of EMG. Differentiate ultrasonic blood flow meter and electromagnetic blood flowmeter. Explain the principle and working procedure for Thermal convection blood flow. [8]
 - b) List the diagnostic medical imaging system. Explain the working of X-Ray machine with functional diagram. Describe the industrial application of X-Ray machine. [8]
4. a) What are the features of Ultrasonic waves? Describe how echo is produced in the generation of ultrasound. Draw and explain the block diagram of CT scanner. [8]
 - b) Describe the principle of MRI machine. Describe the types of dialyzers. Explain how lithotripter machine works with diagram. [8]
5. Write short notes on: [4×4]
 - a) Cardiac pacemaker vs Defibrillator
 - b) Telemedicine architecture
 - c) Subsystem of Telemetry
 - d) Electrical safety and hazards

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (Elective I) (EX 72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



1. a) Design a complete PC-Based ECG Machine with most indispensable components & describe its function briefly. How would you transmit an ECG signal of a patient to the central monitoring unit? Show the connection diagram of three limb leads. [10]
- b) What is ventricular fibrillation? Define cardiac output, & stroke volume. Draw a circuit diagram of DC Defibrillator machine and describe its function. [6]
2. a) How basic pulse echo apparatus coordinate with transmitter circuit to generate large amplitude of pulses and utilize it to view on the display monitor for A mode and B mode display format. [8]
- b) What is CT? Explain scanning system of CT machine with complete schematic layout. What are the four major differences between CT scan and MRI system? [8]
3. a) What is the principle of generation of X-Ray in medicine? Design complete functional X-ray machine with suitable diagram. How X-ray machine is used in video Angiography to assess the blood flow at the blood vessel? [8]
- b) What types of transducer is used in Ultrasonic blood flowmeter? Draw its equivalent circuit. By the help of this transducer how one can measure the blood flow in certain blood vessel? [8]
4. a) What are the differences between EEG and EMG? What types of Electrodes are used to record these signals? Explain EMG recording techniques with some of its applications. [8]
- b) What is Artificial kidney? How it works as a mass exchanger during application in medicine? Draw a layout plan for ESWL machine based on electro-hydraulic principle. [8]
5. a) What is small value of current? How a heart patient who is directly under catheterization procedure is protected from this current? If proper grounding between metallic part and sources is done, how much value of small current will flow through a patient? Assume the value of small current & patient resistance. [6]
- b) Write short notes on: (Any two) [5×2]
 - (i) MRI system
 - (ii) Resting & Action Potentials
 - (iii) Man Instrumentation System & their objectives.

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (Elective I) (EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



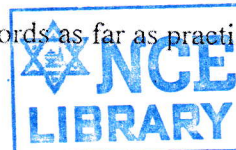
1. a) Differentiate invasive and non-invasive instrumentations system. Explain the different problems encountered while measuring a living system. [8]
b) Define Nerst Equation. Describe Polarization, Depolarization and Repolarization with suitable diagram. [8]
2. a) Define Einthoven's law. Describe ECG waveform. Explain three unipolar limb leads and six unipolar chest lead configurations for ECG measurement. [8]
b) Define evoked potential. Describe three muscle related diseases. Explain the different types of brain waves in normal EEG. [8]
3. a) Define ultrasound. How X-ray machine differs from CT-scan machine? Explain the scanning and processing system of CT-scan machine with complete diagrams. [8]
b) What is defibrillator machine? Differentiate between cardiac pacemaker and defibrillator machine. Describe different types of dialyzers. [8]
4. a) Draw the architecture of Telemedicine. Describe the elements of telemetry system. Explain single channel radio telemetry system. [8]
b) What are the advantages and disadvantages of electromagnetic blood flow meter? Explain electromagnetic blood flow meter with diagram. [8]
5. Write short notes on: [4×4]
 - a) Leakage current and Protection system
 - b) Medical Instrumentation system
 - c) Strain guage
 - d) Magnetic Resonance Imaging

26J TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Bio-Medical Instrumentation (Elective I) (EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.



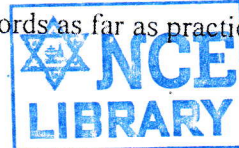
1. a) Differentiate invasive and non-invasive instrumentation system. Explain the problems while measuring a living system. Provide the possible solutions to overcome the problems encountered. [8]
- b) Why is Membrane polarized at rest? Explain the different types of bio-potential electrodes along with the equivalent circuit of bio-potential electrode interface. [8]
2. a) Define piezoelectricity. Explain the piezoelectric transducer with output wave diagrams. List the biomedical applications of piezoelectric transducer. [8]
- b) Define Einthoven's law. Explain the 12-lead ECG configurations with suitable diagrams. [8]
3. a) Define steady state visual evoked potential. Explain the different types of brain waves in normal EEG. List out the use and benefits of EMG. [8]
- b) Describe the ultrasonic blood flow meter. Explain the operation of X-ray machine with its functional diagram. List out the applications of X-ray. [8]
4. a) Differentiate between Cardiac Pacemaker and Defibrillator. Explain dialyzer and its type with clear diagrams. [8]
- b) Describe the frequency division multiple channel telemetry system. Draw the architecture of telemedicine showing the telemedicine unit and base unit. [8]
5. Write short notes on: [4×4]
 - i) Principle of MRI and NMR
 - ii) CT-Scan Machine
 - iii) Electrical distribution system in hospital
 - iv) Leakage current and its type

26J TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (Elective I) (EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt **All** questions.
- ✓ The figures in the margin indicate **Full Marks**.
- ✓ Assume suitable data if necessary.



1. a) Show the differences between electroencephalograph and electrocardiograph. Design an ECG system for the 12 leads recording configuration. Show the connection diagram of three augmented limb leads. [8]
- b) What is transducer? Classify different types of transducer in respect to medical application. Discuss the performance characteristics of transducer in detail. [8]
2. a) What is ultrasonography? Explain basic pulse echo apparatus with its transmitter circuit. State applications of both A mode and B mode display format. [10]
- b) What is Cardiac Fibrillation? How you detect it? Design DC defibrilator machine to restore ECG. [6]
3. a) Explain the working physical principles of all the blood flow meters available and used in medical application. Describe briefly magnetic blood flow meter. [8]
- b) How dialysate is used with medical grade water in mixing chamber to flow properly in exchange chamber of dilyzer during dialysis procedure? Draw a layout diagram of ESWL based on electro-hydraulic method with complete major components. [8]
4. a) Show the differences between computer tomography and magnetic resonance imaging technique with complete schematic diagram. Compare the working principle of both techniques used in diagnosis with help of image reconstruction. Discuss the applications separately. [10]
- b) What are the difference between macro shock and micro shock? Discuss physiological effects of electricity. [6]
5. Write short notes on: (any two) [8+8]
 - i) Telemedicine using mobile communication
 - ii) Resting potential and action potential
 - iii) EEG recording technique and its instrument

36 J TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEX	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (Elective I) (EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks
- ✓ Assume suitable data if necessary.



1. a) Define the terms biomedical engineering and biometrics. Discuss about the factors to be considered to design the medical instruments. [2+6]
b) List various classes of bio-potential electrodes and describe about the construction and operation of micro-electrodes. [8]
2. a) What are active and passive transducers? Discuss about the operation piezoelectric active transducer used in medical field. [2+6]
b) What is ECG? Describe about the various leads of the ECG equipment. [2+6]
3. a) What do you mean by EMG? Draw and explain about the functional blocks of EMG machine. [8]
b) Discuss about the Lithotripsy and its principles. Also list the application of the lithotripter Machine. [8]
4. a) Discuss about the function of the ultrasonic blood-flow meter with the appropriate block-diagram. [8]
b) Draw and explain about operation of MRI-Machine. [8]
5. Write short notes on: (Any four) [4×4]
 - a) Multichannel Telemetry
 - b) Telemedicine through mobile communication
 - c) Micro and Macro-electric shocks
 - d) Protection of the current susceptible patient in hospitals
 - e) X-Ray generation

07C TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instruction (*Elective I*) (EX72503)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. a) What are the six areas of engineering contribution in biomedical field? Design a complete set-up to transmit an ECG signal of man under investigation to the main monitoring unit for ICU in the hospital. What would be the most indispensable components that you need to complete this system?
b) "Bioelectric potentials are actually ionic voltages produced as a result of electro-chemical activities of certain special types of cells," how? Plot the waveform of bio-potentials. Discuss and compare between absolute refractory period and relative refractory period.
2. a) Compare cordial fibrillation with the normal cordial rhythm by plotting normal characteristics of electrocardiogram. How external surface electrodes are used to activate an instrument to restore a normal cordial rhythm. Explain with functional diagram.
b) Why SA node is called pace-maker of the heart? What are the basic components involved in designing a PC based system? Design PC based ECG machine and explain the function of each unit.
3. a) What are the physical principle used for designing magnetic blood flow meter? How magnetic blood flow meter is used to detect blood flow in certain blood vessel? How blood flow is estimated by radiographic technique.
b) What is the basis of generation of ultrasound? What is wave equation? How basic pulse echo apparatus is used to visualize various organs of the body? Explain briefly.
4. a) What are the system components of MRI system? How it detects the nuclear magnetization signal and generates an output signal for processing? Explain with complete diagram.
b) What is dialyzer? Describe its function. How waste products are culled in Halmedialysis machine? Explain with necessary diagram.
5. a) How shock-waves are produced to reduce a kidney stone in electro-hydraulic lithotripter system? What are the main components of a lithotripter system?
b) Write short notes on:
 - i) EMG recording technique
 - ii) Safety aspects of medical instruments

17D TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEX, BCT	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Biomedical Instrumentation (*Elective I*)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
 - ✓ Attempt All questions.
 - ✓ All questions carry equal marks.
 - ✓ Assume suitable data if necessary.
-
1. a) What is wireless telemetry? Discuss the five objectives of man-instrument system in the context of wireless telemetry system. Design a complete set-up for the single channel telemetry system and explain briefly.
b) Why SA node is called pace maker of the heart? Describe the typical characteristics of the normal electrocardiogram. How one can record ECG by using bipolar leads (leads I, II, and III) and also the chest leads (V₁, V₂, V₃, V₄, V₅ and V₆)?
 2. a) Explain electrode theory. "The bio-electric potentials associated with muscle activities constitute the electromyogram". What types of electrodes are used to record these potentials? Explain with all necessary diagrams.
b) Describe the principle of generation of ultrasound. How basic pulse echo apparatus is used to visualize various internal structures of the body? Explain with schematic diagram.
 3. a) What are the differences between haemodialyser and lithotripter? How shock waves are produced to reduce a kidney stone in lithotripter system? What are the main components of a system?
b) What are the main differences between CT-Scan and MRI systems? How MRI system component detects the nuclear magnetization signal and generates an output signal? Explain with necessary diagram. What are the major system components of MRI?
 4. a) What are the physical principle used for designing magnetic blood flow meter? How magnetic blood flow meter is used to detect blood flow in certain blood vessel? How blood flow is estimated by radiographic technique.
b) What are the differences between X-ray machine and nuclear medicine machine? How low level radiation (Radioactive isotope) tracer detection device is used to measure target organ function? Explain.
 5. Write short notes on:
 - a) Safety aspects of medical instruments
 - b) Hacmodialysis machine
 - c) Scanning system of CT-Scan machine
 - d) EEG recording technique