**Group (B): (1 hour / 24 marks)**

1. **What is the effects of radiation on the following:- (8 marks)**
2. Breast (2 marks)

Radiation treatment for breast cancer is usually spread out over 6 weeks with five 2-Gy treatments per week. This results in a total dose of approximately 60 Gy. Late side effects from breast irradiation usually appear one or more years after treatment. The two major long-term complications of breast radiation treatments are fibrosis and lymphedema. Fibrosis is a hardening or stiffening of the tissues due to loss of elasticity due to a diffuse scarring. Lymphedema is a swelling due to local­ized fluid retention caused by damage to the lymphatic system. The complications are the result of the blood vessel and connective tissue damage that were in the radia­tion field.

1. Heart (4 marks)
2. A significant complication of heart irradiation is pericardi­tis. Pericarditis is inflammation of the sac surrounding the heart. The most common symptom of pericarditis is a stabbing, sharp pain in the chest, which becomes stron­ger when exercising or taking a deep breath.
3. Damage to the heart muscle, called cardiomyopathy, most often results in a stiff left ventricle, which does not respond to signals to pump more blood. During strenu­ous physical exercise activity, the stiff left ventricle may not be capable of increased pumping action. When this happens, the blood that is being pumped through the left side of the heart is not pumped out fast enough, and some of the blood backs up in the small blood vessels of the lungs. The oxygen in the lungs is supposed to be transferred to these small blood vessels. When these vessels become engorged with the backlogged blood, the oxygen cannot be transferred to the heart, resulting in congestive heart failure.
4. Damage to the heart valves is a second problem resulting from radiation expo­sure. The heart valves lose flexibility and become stiff following radiation exposure. The stiffened valves do not seal properly and leak blood back into the heart cham­bers, which should be sending blood throughout the body. The amount of blood ejected from the heart during each heartbeat decreases.
5. Radiation can also cause coronary artery disease. Radiation can damage the small blood vessels, which supply the heart with oxygen and nutrition. The interior lining of healthy blood vessels is smooth. Radiation can roughen the inside of blood vessels. These rough spots provide a site for fatty deposits (plaques) to develop in coronary arteries and other arteries and veins. Calcium deposits can harden the plaques resulting in atherosclerosis (hardening of the arteries). Coronary artery disease occurs when one of the heart vessels is clogged with plaque. If this happens, the heart muscle may begin to weaken and die because it cannot get enough oxygen and nutrition.

If the heart tries to beat faster but is deprived of enough oxygen or nutrition, chest pain (angina) results. Angina may last a few minutes until the oxygen gets through the partially clogged artery. If the heart vessel is completely blocked, that section of the heart muscle may die. If the muscle section is small, then the result is a minor heart attack. Blockage of a larger coronary artery supplying a larger amount of heart muscle is damaged; the heart attack is serious and can be life-threatening. The left anterior descending coronary artery is known as the “widow maker” because sudden blockage of it often leads to a fatal heart attack.

1. Liver (2 marks)

Major compli­cations include jaundice and liver failure. Jaundice results in a yellow tint of the skin and the whites of the eyes.

1. **Compare between the ionization chamber and proportional counter? (3 marks)**

**Ionization chambers**

The ionization chamber is the simplest of all gas-filled radiation detectors, and is widely used for the detection and measurement of certain types of [ionizing radiation](https://en.wikipedia.org/wiki/Ionizing_radiation); [X-rays](https://en.wikipedia.org/wiki/X-rays), [gamma rays](https://en.wikipedia.org/wiki/Gamma_ray), and [beta particles](https://en.wikipedia.org/wiki/Beta_particle). Conventionally, the term "ionization chamber" is used exclusively to describe those detectors which collect all the charges created by direct ionization within the gas through the application of an electric field. It only uses the discrete charges created by each interaction between the incident radiation and the gas and does not involve the gas multiplication mechanisms used by other radiation instruments, such as the [Geiger-Müller counter](https://en.wikipedia.org/wiki/Geiger-M%C3%BCller_counter) or the [proportional counter](https://en.wikipedia.org/wiki/Proportional_counter).

The advantages are a good uniform response to gamma radiation and accurate overall dose reading, capable of measuring very high radiation rates, sustained high radiation levels do not degrade the fill gas. The disadvantages are 1) low output requiring sophisticated electrometer circuit and 2) Operation and accuracy easily affected by moisture.

**Proportional counters**

In the proportional region, there is an amplification of the primary ion signal due to ionization by a collision between ions and gas molecules (charge multiplication). This occurs between successive collisions, the primary ions gain sufficient energy in the neighborhood of the thin central electrode to cause further ionization in the detector. The amplification is about 103–104-fold. Proportional counters are more sensitive than ionization chambers and are suitable for measurements in low-intensity radiation fields. The amount of charge collected from each interaction is proportional to the amount of energy deposited in the gas of the counter by the interaction.

The advantages are the ability to measure the energy of radiation and provide spectrographic information, discriminate between alpha and beta particles, and that large area detectors can be constructed. The disadvantages are that anode wires delicate and can lose efficiency in gas flow detectors due to deposition, the efficiency and operation affected by ingress of oxygen into fill gas, and measurement windows easily damaged in large area detectors.

1. **Define the following:- (4 marks)**
2. Ionizing radiation: is radiation with sufficient energy to liberate some of the electrons out of the atoms or molecules in a material that it passes through.
3. Stay time: How long a person can stay in an area without exceeding a prescribed limit.
4. **Explain the following:- (9 marks)**
5. Protons are more penetrating than alpha particles.

Due to having half the charge and are scattered less than electrons due to their greater mass.

1. Lead is a common shielding material for x-rays and gamma radiation.

Because it has a high density, is inexpensive, and is relatively easy to work with.

1. Ionizing radiation used for cancer treatment.

Because it forms ions in the cells of the tissues it passes through as it dislodges electrons from atoms. This can kill cells or change genes so the cells cannot grow.