Current advances in image guided radiation therapy have enabled very accurate delivery of radiation for the treatment of cancer. It then becomes more important that the radiation dose is calculated with utmost accuracy in patient geometry. For past two decades Monte Carlo (MC) methods have been known to be the most accurate methods available for dose calculation. However, it has been only recently that MC based commercial treatment planning systems are becoming available for routine use in the clinic. Even now radiation therapy community is struggling in adopting MC treatment planning systems (TPS) as the only TPS in the clinic. This is either because of additional computational burden associated with the MC dose calculation or due to the lack of information available on clinical benchmarked data where the effect of MC is most significant. Although use of parallel processing and more recently GPU implementation of MC algorithms have overcome computational burden, the need for clinical use and significance of MC methods are still topics of debate.

The main goal of this educational session is to familiarize clinical medical physicists with the application and implementation of Monte Carlo in routine radiotherapy treatment planning with the emphasis on the clinical significance. The continuing education session will be divided into two sections in order to specifically address implementation issues related to Monte Carlo-based photon and electron treatment planning techniques. The following broad general topics will be addressed:

1. **Introduction to Monte Carlo methods:** with its application to radiation treatment planning and commercial availability of MC based TPS
2. **Commissioning and clinical implementation of MC based systems**- Beam data required for source modeling and commissioning of a MC based TPS. Use of MC in IMRT optimization and VMAT for photon treatment planning
3. **Implementation, operational and physics related issues:** Issues related to beam modeling, inherent statistical uncertainty in MC dose calculations, importance of CT-to-material conversion and dose reporting in terms of dose-to-medium versus dose-to-water.
4. **Clinical significance of MC based treatment plans:** Dosimetric differences of MC dose calculations compared to kernel based methods for treatment sites such as head and neck, spine, breast, lung etc and how it affects our current clinical practice in terms of new prescription and dose escalation.
5. **MC as a QA tool?** Use of MC method as an independent and additional QA tool. Effect of QA by calculating dose in actual patient geometry rather than water phantom. Accounting for machine delivery uncertainty by reconstructing doses from machine log files etc

Education Objectives

1. A review of MC methods with its application to radiation treatment planning for photon and electron beams
2. To understand the clinical implementation and commissioning of MC based TPS and issues related to its routine clinical operation
3. To understand the clinical significance of MC methods for different treatment sites and how it change our current clinical practice
4. To understand the use of MC TPS as an additional and independent QA tool in routine clinical practice.