Linax Medical Linac Course Syllabus

Based on Materials from the Linax course space and labs using the Simac simulator
3 course parts, 21 teaching sessions

Part 1

Sessions 1 and 2. Introduction and Overview

Instructor and student backgrounds. Purpose of the course, use of a simulator in learning about medical linear accelerators. Major manufacturers and the differences between their linac styles. Overview of major components: Electron Gun, Bending Magnet, Target, Klystron, Magnetron, Modulator, RF System (RF Waveguide, Circulator, Isolator), Water Cooling System, Pneumatic System, Dose Chamber, Gantry, Collimator, Carrousel, KV and MV imaging.
Learning objective: Understand the major components in a linear accelerator and their purpose

Sessions 3 – 5: Simac Labs: *RF Driver, Beam Loading, Bending Magnet, Klystron Pulse Voltage, Beam Finding, Beam Symmetry, Flattening Filter.*

Learning objective: Understand how major components in a linear accelerator function, and how they are related to each other

Session 6 and 7. Linac Safety

General electrical and linac safety. High voltage safety. Gun Deck safety. Hazardous materials & SF6 safety. Mechanical safety. Radiation safety.
Learning objective: Understand the hazards in linear accelerators. Understand how the hazards affect the safety of the service technician, the patient, and the machine.

Session 8: Physics QA

Dosimetry calibrations. Beam steering: Flatness and symmetry.
Learning objective: Understand linear accelerator quality assurance

Part 2

Session 1 and 2. Electron Gun

Electron Beams: Injection into Accelerator, injection into klystron. Anode and cathode for each. Components: cathode heater, filament, electron cloud, grid, beam forming electrode. Gun emission: dispenser cathodes, thermionic diode, cathode characteristics. Gun operation: Using the grid, gun timing pulse, capture efficiency.
Learning objective: Understand the electron source and how it is controlled

Session 3 and 4: Waveguide

Accelerator waveguide: Diagram, Gun input, Modulator input, transmission and accelerating waveguides, electric fields in cavities, accelerator timing, standing wave, traveling wave, how a standing waveguide is manufactured, energy switch, shunt impedance.
Learning objective: Understand the accelerating waveguide and its mode of operation

Session 5 and 6: Bending Magnet, Target

Bending Magnet: poles, energy slit, achromatic focusing, electron bandwidth. Target: electrons, low-x, and hi-x, target materials, Bremsstrahlung. Carrousel: different filters, beam Shaping.
Learning objective: Understand the bending magnet, and how it affects the beam energy

Session 7 and 8: Ion Chamber, Carrousel, Collimator, Jaws & MLC

Ion chamber components: Varian, Elekta. How an ion chamber works, triax cables. MLC: segments use to conform to tumor shape. Jaws: Field size definition.

Learning objective: Understand the beam delivery system

Part 3: High Voltage

Session 1: Klystron

Klystron, mode of operation, electron bunching, practical examples

Learning objective: Understand the klystron's mode of operation and how they work in a medical linac

Session 2: Magnetron

Magnetron, mode of operation, performance charts, magnetic field dependence

Learning objective: Understand the Magnetron's mode of operation and how they work in a medical linac

Session 3: Modulator

High voltage modulator: HV power supply: 3 phase (208 VAC), step start circuit, step-up transformer, 6-way bridge, charging choke, charging HV diodes, PFN, stand transformer, step-up voltage to the klystron, main thyratron, De-Q thyratron. Simplified diagrams of thyratron and power supply. Charging cycle, power supply voltage doubling, De-Q circuit, PFN discharge.

Learning objective: Understand the charging and discharging cycles in a high voltage modulator

Session 4: Waveforms and typical values

Waveform shapes, waveform troubleshooting. Preventative Maintenance. Numbers recorded in the PMs and what to watch for when troubleshooting. Examples of HVOC and Dosimetry

Learning objective: Understand pulsed waveforms and how to use these to interpret machine performance

Session 5: Preventative maintenance

Typical operating values of modulator, gun, beam currents, bending magnet and other linac operating points. Recording of values, troubleshooting based on recorded machine values

Learning objective: Understand the purpose of preventative maintenance and it's use in trouble shooting linac problems

Sessions 6 – 8: Bonus sessions for questions and problem solving

Learning objective: To allow the student to ask questions not covered in the course and to discuss linac troubleshooting procedures.