Service Technician Course Syllabus

Based on Materials from the course space and labs using the simulator.
3 course parts, 23 teaching sessions and 1 review session.

Part 1

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

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

Linac Safety

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

Physics QA

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

Part 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

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

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

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

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

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

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

Waveforms

Waveform shapes, waveform troubleshooting. High voltage charging and discharging. Modulator voltage and current pulses, pulse timing, RF reflected, gun triggers. Duty cycle. Examples of realistic waveforms and use in troubleshooting.

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

Preventative and corrective 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, troubleshooting process. Values recorded in the PMs and how to use these when troubleshooting.

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

Bonus sessions for questions, problem solving, and unfinished material.

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