LINAX TECHNOLOGIES
2024 COURSE CATALOG

Linax Technologies Ltd.
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Canada

https://linax.ca

learning@linaxtechnologies.com

All training uses Simac the linac simulator for safe unlimited beamline access and are delivered 100% virtually.

2024 COURSE CATALOG

Linax introduces general linac training for Service Engineers and Medical Physicists on ANY linac to reduce training time needed on machines by up to 80%, reduce onboard training by up to 9 months, and overall reduce training costs.
Complimentary to vendor training, Linax takes all the pressure of building and delivering while providing training from onboarding to continuing education and regulatory compliance

3 TRAINING OPTIONS

LINAC SERVICING COURSES

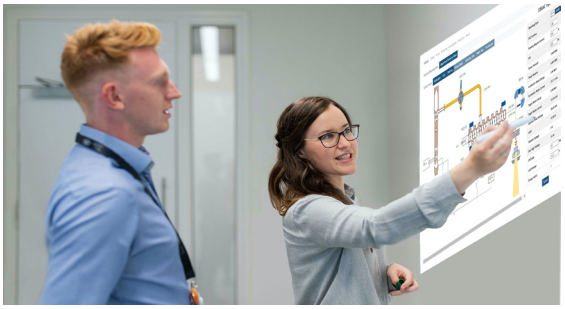
3 Levels; take individually or Bundle

Courses taught by a Linax Instructor to teach practical linac servicing on any medical linac. 1-hr sessions, two times a week. Flexible days of the week that suit technician schedules.

LINAC TRAINING PACKAGES

Resident, Graduate, Clinic

Get access to all our resources, teaching material, and classroom management features to deliver linac training on your own and develop an in house program for years to come.



INDIVIDUAL COURSES

Self-directed courses and exams to provide professional development and regulation compliance opportunities for linac professionals.

LINAC SERVICING COURSES

Courses taught by expert Linac instructors.
Learn how to service any medical linac. No travel, never disrupt work schedule.

1 hr sessions ~ 2 times a week. Available in English or Spanish

LEVEL 1: LINAC COMPONENTS

Learn the basic components of medical linear accelerators and their principles of operation. Understand how a linac operates and how to apply that knowledge to servicing.

8 Sessions ~4 weeks

LEVEL 2: LINAC SAFETY & HAZARDS

Learn linear accelerator safety, hazards, interlock theory, and patient safety. Introduction to preventative and corrective maintenance, and quality assurance procedures for medical linac maintenance.

8 Sessions ~4 weeks

LEVEL 3: ADVANCED MAINTENANCE & TROUBLESHOOTING

Learn the aspects of advanced beam tuning. Become a technician prepared for the most challenging troubleshooting. Understand and anaylize waveforms and AFC systems.

8 Sessions ~4 weeks

CERTIFICATION UPON COMPLETION

KEEP PLATFROM ACCESS FOR 1 YEAR AFTER COURSE COMPLETION!

Syllabuses on page: 15,16, & 17

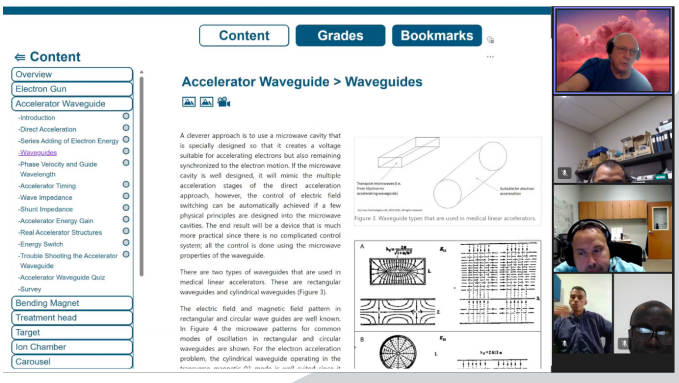
MOST POPULAR*

MASTER COURSE: ALL 3 LEVELS

Become a certified technician ready to operate, troubleshoot, maintain, and repair any medical linacs safely and confidently.
Reduce on boarding by 6 months.

26 sessions ~ 3 months

Master Courses start January, April, July, October, or on demand.



BY QUOTE: LEARNING@LINAXTECHNOLOGIES.COM

LINAC TRAINING PACKAGES

Get access to all Linax content, teaching material, classroom features, and linac simulator to deliver training on your own. Perfect for Resident programs, Graduate programs, or the entire clinic.
Teach complex procedures and operation safely, quickly, and easily.

RESIDENT PACKAGE

Teach your medical physics residents about linac operation and quality assurance. Compliment your program with the resources and exercises students need to become confident with medical linacs

Access duration: 12 months

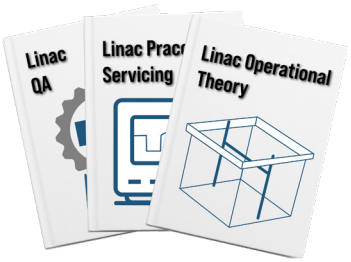
GRADUATE PACKAGE

Teach your medical physics graduate students about linac theory and quality assurance. Compliment your program with the resources and exercises students need to become confident with medical linacs
Access duration: 4 months
Users: 0-10 students or 10+ students

All Packages Include:

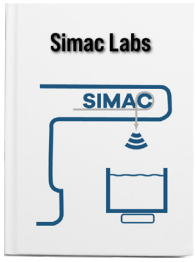
Simac
-Klystron Linac simulator
-Magnetron Linac Simulator
-Water Tank Simulator

+



Textbooks w Chapter Quizzes
-Linac Operation Theory
-Linac Practical Servicing
-Linac Quality Assurance

+



Simac Lab Exercises
- 21 guided Simac exersices
-Real linac procedures

Textbook Contents Pg 6-14

CLINIC PACKAGE

Get access to Linax's entire training resources. Teach medical physicists and Service technicians linac operation, linac safety, and clinical responsibilities all on your own.
Give the professionals the resources and training they need to be conident while reducing training times and costs.

Access duration: 12 months

BY QUOTE: LEARNING@LINAXTECHNOLOGIES.COM

INDIVIDUAL COURSES

Self-directed courses and exams to provide professional development and regulation compliance opportunities for linac professionals.

REGULATORY COMPLIANCE

LINAC PROFESSIONAL PRACTICE COURSE

Learn the non-technical aspects of a Class 2 Service Technician in Canada. Including clinic, behavioral, regulatory, and ethical knowledge.

Designed to show complinace with new CNSC Class 2 guidelines.

Certification upon completion.
Self-Directed. ~2-4 weeks

Cost: $800 CAD

TECHNICAL EXAMS

Do you already have advanced linac knowledge and don't need a course? Take our technical exams to establish your technical competence.

Designed to show complinace with new CNSC Class 2 guidelines.

Certification upon completion.
90 minute exams

Cost: $650

SELF-DIRECTED

LINAC BOOTCAMP

An introduction to Linac education while experiencing the Linax platform. Get a basic overview of linacs while seeing how we and you can use Simac and the rest of the platform to make teaching medical linacs simple.

Video Course
7 Videos, 7 Simac Demonstrations

Cost: $150

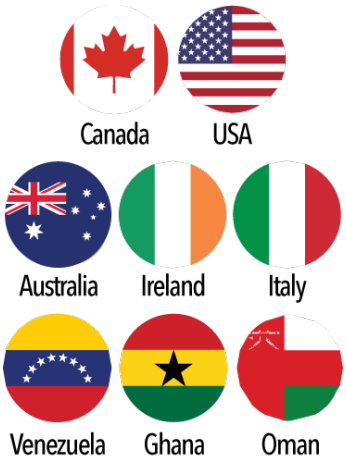
HEAR FROM OUR AMAZING CUSTOMERS

15

15 institutions use Linax Training Packages

20+

Linax has certified over 20 technicians globally



SIMAC provides a unique environment where our students can gain familiarity with how medical linear accelerators work. SIMAC has played an important role in the education of our graduate students for a number of years now.
Justus Adamson, PhD, Associate Professor, Department of Radiation Oncology, Duke University Medical Center

The SIMAC software and related product offerings were a great resource for us. Our electronics technicians used the simulation software during the linac related training and found it very helpful. It all fits together nicely - Hats off to the Linax team. Much appreciated!
Gavin Sranmer-Sargison, Director of Medical Physics, Saskatchewan Cancer Agency

Access to vendor training on linear accelerators has been very difficult in the last couple of years. We have struggled to get training for a new service technologist. Furthermore, we do not have the resources to setup an in-house training program. I felt that the course offered by Linax provided a thorough and complete introduction to the operations of medical linear accelerators. This overview is great for new staff that have not received exposure to this type of physics and technology. Most of our new hires are graduates from collegiate electronic technologist programs. These programs are too general to touch on something as specialized as linear accelerators. The Linax course bridges that knowledge gap very well.
Clément Arsenault, Chief Physicist at the Réseau de santé Vitalité Health Network, Moncton, NB

The Linax course hit the mark. It was the perfect training to break into the field and prepare them for the manufacturer training later on when it becomes available and the finances are available. It's not a replacement for the manufacturer training, but it fits nicely as part of the development process.
Kirby Farris, Clinical Engineering Manager, Service New Brunswick

Teaching and learning the operational details of a medical linear accelerator is one of the most challenging tasks in medical physics education. Developing an intuitive appreciation for the dynamic nature of the electromagnetic acceleration of electrons does not come from staring at complex equations in a textbook. Experimental access to a real accelerator is limited to off-hours and manipulation of operational parameters is risky for a machine in clinical operation with heavy demand. A computer simulation tool is long overdue, and it overcomes the above limitations with self-paced learning available "any time anywhere". SIMAC software is coupled with a comprehensive course package based on the author's decades of real-life experience in maintaining clinical megavoltage accelerators. It features graphical material and ample user interaction with the key LINAC components, their design, and their settings. For example, the effects of changing the x-ray target or flattening filter materials on the output dose rate and energy spectrum can be observed graphically. SIMAC is a welcome addition to training programs in clinical physics and biomedical engineering.
Jerry Battista, PhD, FAAPM, FCOMP Professor Emeritus Recipient of Pleva Award for Excellence in Teaching Western University, London, Canada

Linac Operation Theory Textbook

-Ion Chambers in Medical Linacs
-Ion chamber current collection
-Linac Calibration
-Dose Rate Control
-Dose rate servo

Chapter 7: Klystrons

-Microwave power sources for medical linear accelerators
-Klystron overview
-Description of the klystron's mode of operation
-Bunching process
-Klystron saturation
-Klystron Modelling
-Magnetic focusing
-Klystron construction

Chapter 8: Magnetrons

-Mode of Oscillation
-Magnetron anode and RF
-Resonant modes
-Mode separation
-Magnetron cathode
-Bunch formation in rotational motion
-Output coupler and frequency tuning
-Magnetron operating values

Chapter 9: Modulators

-Resonant Charging
-Pulse Forming Network (PFN)
-Thyratron switch
-PFN Discharge
-Pulse transformer
-Pulse noise

Chapter 10: Waveforms

-Pulse timing in a medical linear accelerator
-Pulsed nature of the linear accelerator
-Relationship between gun injection, reflected RF power, and beam output

Linac Practical Servicing Textbook

Chapter 1: Electron Gun

-Electron Path Through the Medical Linac
-Behaviour of the electron gun
-Dispenser Cathodes
-Thermionic Diode
-Diode Electrical Characteristics
-Capture Efficiency
-Gun Current Control

Chapter 2: Accelerator Waveguide

-Direct Acceleration
-Series Adding of Electron Energy
-Waveguides
-Phase Velocity and Guide Wavelength
-Accelerator Timing
-Wave Impedance
-Shunt Impedance
-Accelerator Energy Gain
-Real Accelerator Structures
-Energy Switch
-Trouble Shooting the Accelerator Waveguide

Chapter 3: Bending Magnet

-Achromatic focusing
-Bending Magnet Current
-Energy Slits
-Bend Magnet Examples
-Bend Magnet Construction

Chapter 4: Treatment head

-Simple Theory of Bremsstrahlung
-Example with Tungsten
-Bremsstrahlung Production Efficiency
-Energy Dependence of Angular Photon Distribution
-Bremsstrahlung Directional Dependence
-Flattening Filter: Beam Flatness and Symmetry

Chapter 5: Target

- Mechanical Makeup of the Target

Chapter 6: Carousel

-Mechanical Makeup of the Carrousel
-Flattening Filters

Chapter 7: Ion Chamber

-The Triax Cable
-Ion Chamber in Medical Linacs
-Ion Chamber Current Collection

-Varian Style Ion Chamber
-Elekta Style Ion Chamber
-Linac Calibration
-Dose Rate Control
-Dose Rate Servo

Chapter 8: Collimator
-The Collimator Jaws and Light Field
-The Multi-Leaf Collimator (MLC)

Chapter 9: Klystron
-Microwave Power Sources for Medical Linear Accelerators
-Klystron Overview
-Description of the Klystron's Mode of Operation
-Bunching Process
-Klystron Saturation
-Magnetic Focusing
-Klystron Construction

Chapter 10: Magnetron
-Power Sources
-Mode of Oscillation
-Magnetron Anode and RF
-Resonant Modes
-Filament heater cutback
-Bunch Formation in Rotational Mode
-Output Coupler and Frequency Tuning
-Magnetron Operating Values

Chapter 11: Modulators
-PFN Discharge
-PFN Charging
-Thyratron Switch
-Pulse Transformer
-Modulator Module Preventative Maintenance

Chapter 12: Safety Theory
-Safety Concepts
-Systems
-STAMP

Chapter 13: Linac Hazards
-Disabling linac operation when servicing
-Transmission waveguide
-Presence of other hazardous materials in the linear accelerator - Material Safety Data Sheets
-Ozone
-Mechanical hazards in medical linear accelerators
-Electric Shock Hazard
-Microwave Tube Operating Hazards
-High Temperature Surfaces
-Laser Beams

-Other safety areas

Chapter 14: Linac Incidents

-Incident at Białystok, Poland
-Incident at Zaragoza, Spain
-Therac 25 accidents
-Varian Symmetry Recall

Chapter 15: Interlocks

-Case Study 1: Therac 25
-Case Study 2: Spain Incident
-Case Study 3: Poland Incident
-Varian Interlock Upgrade
-Interlocks & Safety Systems Summary

Chapter 16: Waveforms and Numbers

-Pulse timing in a medical linear accelerator
-Pulsed nature of the linear accelerator
-RF Reflected pulse
-Typical values, and the use of preventative maintenance

Chapter 17: Heat Management

-Sources of heat in medical linacs
-Water cooling
-Cooling circuits for two accelerator configurations
-Accelerator temperature control

Chapter 18: AFC

-Principles of an Automatic Frequency Control system
-AFC systems for linear accelerator frequency control
-AFC components

Chapter 19: Preventive Maintenance

-Scheduling
-Downtime Reduction

Chapter 20: Corrective Maintenance

-Service request Process
-Site Preparation
-Trouble Shooting
-Repairs
-Commissioning and Decommissioning
-Maintenance Management
-Parts
-Waste Disposal

Quality Assurance Textbook

Linax Technologies SIMAC Labs

SIMAC Lab 1:

-Beam Loading
-Energy Correction with Bending Magnet
-Flattening Filters
-Beam Steering Part 1
-Beam Steering Part 2
-Adjusting the RF Driver
-Adjusting the Klystron Pulse Voltage
-Beam Finding

SIMAC Lab 2:

-The PFN charging cycle
-The de spiking circuit
-Magnetron output power
-RF reflected pulse
-Electron Gun
-Beam loading for travelling wave accelerator with diode gun
-Beam loading for standing wave accelerator with triode gun
-RF feedback phase adjustment for travelling wave accelerator
-Steering for 270 degree bend magnet
-Steering for slalom style bending magnet
-270 degree bending magnet
-Slalom style bending magnet
-Klystron pulse voltage
-Electron beam angle of incidence on target
-Effect of feedback loop on travelling wave load line
-Effect of energy switch on load line for a standing wave accelerator

Linax Technologies Professional Practice

Chapter 1: Introduction to Radiotherapy in Canada
- *-Medical Linac Service technician job requirements*

Chapter 2: Role of Radiation in Cancer
- *-Radiotherapy Clinic Structure*
- *-Roles in Radiotherapy*
- *-Radiotherapy process, scheduling, and time course*

Chapter 3: Health Care Institutions Governance and Leadership
- *-Health Care Staff types*
- *-Budgets and financial accounts*
- *-Health care leadership*

Chapter 4: The legal framework for Class II service technicians
- *-Canadian Nuclear Safety Legal and regulatory overview for medical linear accelerators*
- *-Occupational Health and Safety regulatory overview for medical linear accelerators*

Chapter 5: Radiation Safety for Class II service technicians
- *-Radiation Safety Principles*
- *-Radiation protection for medical linac servicing*

Chapter 6: Hazards when servicing medical linear accelerators
- *-General safety conditions*
- *-RF/microwave hazards*
- *-Hazardous materials*
- *-Mechanical hazards*
- *-Electrical hazards*
- *-Personal Protective Equipment*

Chapter 7: Linear Accelerator Repairs and Return to Service
- *-Return to service process*
- *-Instruments for linear accelerator quality assurance work*
- *-Quality Assurance Protocols*
- *-Frequency of quality assurance testing*

Chapter 8: Professional practice for the linac service technician
- *-Medical and Professional Ethics*
- *-Ethics and Law*
- *-Duty to the public and environment*
- *-Duty to the employer*
- *-Patient Privacy*
- *-Case Studies*

Chapter 9: Maintenance of competence

-Maintenance of competence as an ethical obligation
-Membership in a provincial association for technologists
-Types of continuing education
-Sources of continuing education
-Keeping records of continuing education and continuing education plan

Service Technician Level I Syllabus

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

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

Klystron Overview

Learning objective: Understand what a klystron is and how it is used in a medical linac

Magnetron Overview

Learning objective: Understand what a magnetron is and how it is used in a medical linac

Modulator

Charging and discharging of PFN (use physics course space material)

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

Service Technician Level II Syllabus

Simac Lab 1:

RF Driver, Beam Loading, Bending Magnet, Klystron Pulse Voltage, Beam Finding, Beam Symmetry, Flattening Filter.

Learning objective: Introduction to linac components and how they are connected

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.

Advanced Lab: Relative output factor and profile dependence on field size

Learning objective: Understand linear accelerator quality assurance

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

Examples of linac troubleshooting problems

Simac Lab 2

1. *Beam Loading travelling wave*
2. *Beam Loading Standing wave*
3. *Steering 270 degree bend magnet*
4. *Steering slalom bend magnet*
5. *Electron beam angle of incidence on target*
6. *270 degree bend magnet*
7. *Slalom style bend magnet*

Learning objective: Understand the how components respond to changes to help in troubleshooting process

Service Technician Level III Syllabus

Advanced Waveguide theory and operation

Energy switch for standing wave
Feedback loop for travelling wave
Learning objective: Understand how waveguide configuration is related to beam energy and linac operating values

Advanced 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

Advanced 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

Advanced 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

Advanced RF systems

Circulator, High power load, Waveguide window
Learning objective: Understand the medical linac RF systems

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

Water systems and Automatic Frequency Control

From Physics course space
Learning objective: Understand how heat and temperature affect the linac operation

Simac Lab 2

1. *PFN Charging cycle*
2. *deSpiking circuit*
3. *RF Reflected Pulse*
4. *Electron Gun*
1. *Klystron pulse voltage*
2. *Magnetron output power*
5. *RF feedback phase adjustment*
6. *Effect of feedback loop on travelling wave load line*
7. *Effect of energy switch on load lone for standing wave accelerator*