ETI 101 Syllabus

Fundamentals of Nuclear Science and Engineering for Nonproliferation

Objective

The course objective is to engage the ETI academic community and introduce foundations of nuclear science and engineering as they apply to non proliferation problems.

Delivery

Online, synchronous and asynchronous

Schedule

Kick off - January 10, 2023.

Online meetings - T/Th 11:10 - 12:30 Eastern Time, weekly

unless otherwise indicated in the detailed schedule below. Note there are a few deviations.

Live Lecture Access

Zoom: *https://gatech.zoom.us/j/94923398086*

1st week:

January 10 - kick off at 11:10:

11:10 - ETI Consortium and ETI 101, Anna Erickson, ETI Consortium Director
11:20 - ETI 101 Organization and Logistics, Pavel Tsvetkov

Lectures

Module 1 - Nuclear science of radiation interactions and applications

Module lead: R. Cao
Lecturers: S. Biegalski, P. Tsvetkov, R. Cao, M. Short
4 weeks, 8 lectures (January 10 - February 2)

Jan 10 Jan 12, 2023	11:10 - 12:30 11:10 - 12:30	• Energy and units, fundamental physics background, special relativity. • Atoms and nuclei, nuclear structure and data files, relative stability and energy conservation. • Radioactivity, nuclear stability, radioactive decay, decay chains.	Steven Biegalski, Georgia Tech.
Jan 17 Jan 19, 2023	11:10 - 12:30 11:10 - 12:30	• Neutron interactions, neutron reactions and neutron cross sections • Nuclear processes, nuclear reactions, transmutation, conservation principles, reaction rates, particle attenuation. • Nuclear data and evaluated nuclear data files. • Fission, process, energy considerations, energy from nuclear fuels.	Pavel Tsvetkov, Texas A&M
Jan 24 Jan 26, 2023	11:10 - 12:30 11:10 - 12:30	• Ions, electrons and neutrons interaction with matter and detection. • Gamma interactions with matter and detection.	Raymond Cao, Ohio State
Jan 31 Feb 2, 2023	11:10 - 12:30 11:10 - 12:30	• Materials Science 101 - The very basics and mechanical properties for nuclear engineers • Radiation effects and damage on nuclear materials for reactors and forensics	Michael Short, MIT

Module 2 - Nuclear engineering of reactors and systems

Module lead: Pavel Tsvetkov (TAMU)

Lecturers: Pavel Tsvetkov (TAMU), Abdalla Abou-Jaoude (INL)

3 weeks, 6 lectures (February 7 - February 23)

Feb 7 Feb 9, 2023	11:10 - 12:30 11:10 - 12:30	• How do nuclear reactors work? • Energy conversion – Applications • Nuclear power plant – heat generation, removal, components and operational aspects	Pavel Tsvetkov, Texas A&M
Feb 14 Feb 16, 2023	11:10 - 12:30 11:10 - 12:30	• Reactor types and applications • Nuclear safety, security, safeguards • Decommissioning	Pavel Tsvetkov, Texas A&M
Feb 21 Feb 23, 2023	11:10 - 12:30 11:10 - 12:30	• Fusion • Advanced Reactor Design and Proliferation • Nuclear Batteries	Pavel Tsvetkov, Texas A&M Abdalla Abou-Jaoude, Idaho National Lab. Pavel Tsvetkov Texas A&M

Module 3 - Nuclear fuel cycle and waste management

Module lead: Paul Wilson (U. Wisconsin)

Lecturers: Paul Wilson,

3 weeks, 6 lectures (February 28 - March 16)

Feb 28 Mar 2, 2023	11:10 - 12:30 11:10 - 12:30	• Overview of fuel cycle • Enrichment Technology	P. Wilson (UW) P. Wilson
Mar 7 Mar 9, 2023	11:10 - 12:30 11:10 - 12:30	• In-core fuel management & Burnup • Partitioning & Transmutation Technology	P. Wilson P. Wilson
Mar 14 Mar 16, 2023	11:10 - 12:30 11:10 - 12:30	• Waste Classification & Management • Fuel Cycle Comparisons (incl. Th)	P. Wilson P. Wilson

Module 4 - Nexus of Technology and Policy

Module leads: Anna Erickson (Georgia Tech.), Sarah Frazar (PNNL)
Lecturers: Robert Marek, M. Albertson. Kate Doty, Rob Goldston, Anna Erickson, Kendra Biegalski
3 weeks, 6 lectures (March 21 - April 6)

Mar 21 Mar 23, 2023	11:10 - 12:30 11:10 - 12:30	• History and Development of Nonproliferation System • Deterrence and Arms Control in a Multi-Polar Global environment	Robert Marek Michael Albertson
Mar 28 Mar 30, 2023	11:10 - 12:30 11:10 - 12:30	• International Treaty Context of Nonproliferation and Arms Control • Verification Activities, Techniques and Instrumentation	Frank Putzu Rob Goldston
Apr 4 Apr 6, 2023	11:10 - 12:30 11:10 - 12:30	• Additional Protocol, State Level Concept, and Future of International Safeguards • National and International Laws and Organizations Supporting Nuclear Security and Nonproliferation	Anna Erickson Kendra Biegalski

Module 5 - Overview of nuclear security and nonproliferation

Module lead: Robert Brigantic (PNNL)

Lecturers: E. Mace, M. Schanfein, M. Short, D. Haas, Sunil Chirayath, E. Brubaker, M. Carpenter, R. Bean

4 weeks, 8 lectures (April 11 - May 4)

Apr 11 Apr 13, 2023	11:10 - 12:30 11:10 - 12:30	• PNNL Shallow Underground Laboratory for Trace Detection – Virtual Tour • Into the Mind and Challenges Faced by IAEA Inspectors In A Nuclear Facility	Emily Mace Mark Schanfein
Apr 18 Apr 20, 2023	11:10 - 12:30 11:10 - 12:30	• Stored Energy Fingerprints for Treaty Verification • Nuclear Explosion Monitoring	Michael Short Derek Haas
Apr 25 Apr 27, 2023	11:10 - 12:30 11:10 - 12:30	• Radiation Imaging and its Applications in Nuclear Non-Proliferation • Fundamentals of Nuclear Material Accountancy (NMA)	Erik Brubaker Sunil Chirayath
May 2 May 4, 2023	11:10 - 12:30 11:10 - 12:30	• Destructive and Non-destructive Assay Techniques • Radiation Detection Systems for Safeguards and Security Applications	Matt Carpenter Robert Bean