

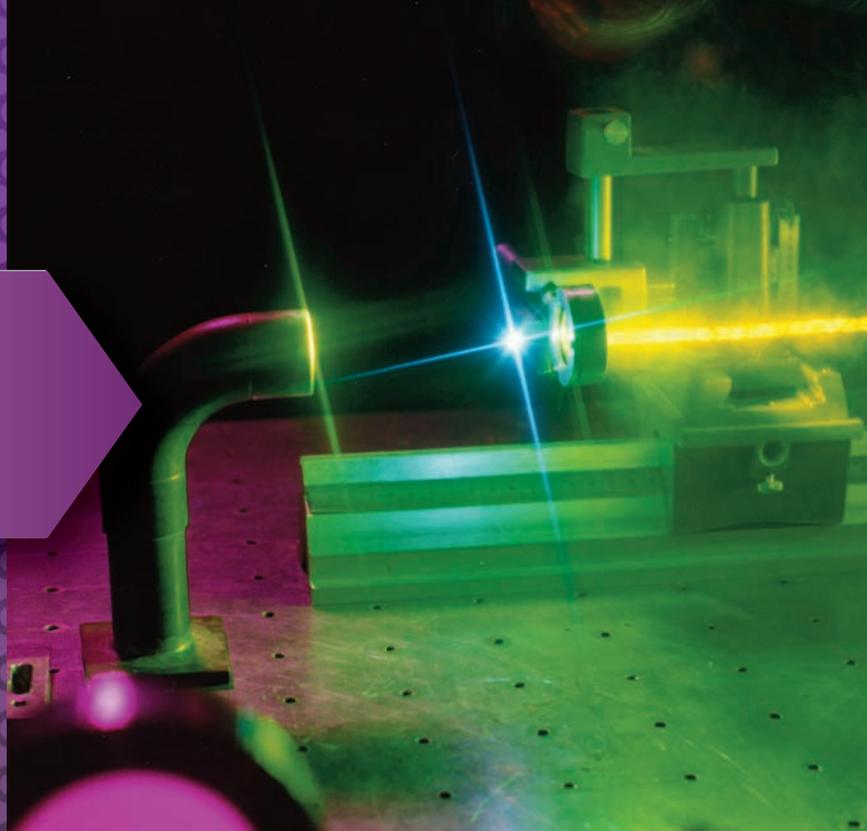


# Lasers & Application

## Why study this module?

This module presents a thorough introduction to the field of laser materials processing. It is assumed that you have no prior knowledge of laser material interactions although it is assumed that you are familiar with general principles of materials science and engineering. The Lasers and Applications module introduces biological Science graduates to introduces you many facets of laser technology including:

- Laser sources, the generation of laser light.
- Laser beam delivery, the delivery of laser energy to a material.



- Laser material interactions, the fundamentals of how laser energy interacts with matter.
- Laser materials processing, how laser material interactions can be harnessed to generate reliable manufacturing processes in industry.
- Laser safety, how laser sources can generate hazards and how these can be addressed by implementing the best practice described in laser safety standards.

## Module content

Beginning with a description of the principles of operation of a laser, and an overview of the different laser types that are widely used in applications, the Laser and Applications module will detail the interaction of high-power laser beams with a range of materials. Topics will include welding, cutting, drilling, marking, heat treatment, and prototyping using lasers and will also deal with low-power laser application in inspection, quality control, and other diagnostic tools.

## Learning outcomes

On completion of this module you will be able to:

- Explain the fundamentals of laser operation
- Explain the functionality of different opto-electronic components in a laser-based manufacturing system
- Apply concepts in laser material interactions in laser process development
- Analyse the photo-physical response of materials when exposed to laser energy

- Categorise the principal factors contributing to a manufacturing process based on laser technology
- Evaluate the performance of a laser process and suggest routes for improvement
- Give a quantitative appraisal of the energy density required to achieve different effects
- Summarise related optical systems
- Describe the safety issues associated with high power lasers

## Module facts

Course level: Level 9

Module credit: 5 ECTS. Gain transcript or use towards PG Cert/PG Dip/MSc qualification in Biomedical Science

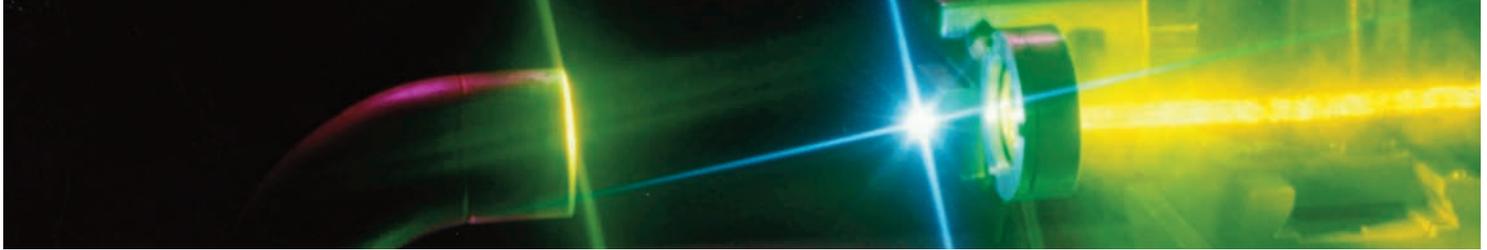
Duration: Over one semester

Entry Requirements: Please refer to the application section of the programme brochure

Fees: €1,000

Applying: [www.nuigalway.ie/apply](http://www.nuigalway.ie/apply)

Closing date: 2 – 8 weeks prior to module start date



## Module topics

### Introduction and Overview

- Historical perspective & impact of laser technology
- Properties of laser beams
- Advantages of laser technology as a manufacturing tool
- Current applications in biomedical engineering

### Laser Sources

- Generation of laser light
- Laser light generation in gas lasers
- Laser light generation in solid state lasers
- Future perspectives

### Laser Beam Delivery

- Beam propagation
- Passive optical components
- Active optical components
- Beam metrologies

### Laser Material Interactions

- Absorption of light in materials
- The photophysical response
- Role of the ambient Delivery

### Laser materials processing

- Material removal / subtractive processes
- Material deposition / additive processes
- Hybrid processes
- Future perspectives

### Laser Safety

- Hazards of laser radiation
- Overview safety standards
- Implementing laser safety
- Risk assessment of beam hazards

### Laser Laboratory



## Student testimonial



### Yvonne Brennan

#### Current Position:

Process Quality Engineer, Process Development Endoscopy.

“I found the Lasers and Laser Applications module particularly interesting as we use lasers in many applications in my workplace, but little is communicated about the underlying science. The lectures were very relevant to industrial applications and have considerably increased my understanding of material interactions and material processing. It was all presented in a clear, concise and logical manner and at a pace which did not discourage the non-engineers. Understanding the variables involved in laser processing is a great help in problem-solving when issues arise. I would recommend this module to anyone involved in manufacturing who wants a solid grounding in the subject.”



## Module Director

### Dr. Gerard O'Connor

This module is delivered by Dr. Gerard O'Connor, who received his BSc from NUI Galway in Experimental Physics in 1989. He was awarded a PhD on spectroscopic characterisation of III-V alloys semiconductor alloys in 1994.

He then accepted a position as a Materials Scientist at the National Microelectronics Research Centre (now Tyndall National Institute), University College Cork. He was appointed Lecturer and Senior Lecturer in the school of physics at NUI Galway in 2005 and 2007, respectively. Gerard teaches undergraduate courses in quantum physics and nanotechnology and was appointed as Deputy Head at the School of Physics in 2009 and a Director to the National Centre for Laser Applications in 2011.

He is the lead investigator for NUI Galway on the Integrated Nanoscience Platform for Ireland (INSPIRE) since 2007. He is the coordinator on the FP7 Laser Connect Marie Curie project awarded in 2010. In addition, Gerard acts as external examiner for the laser engineering programmes at the University of Liverpool. He sits on the inter-institutional committee for Tyndall's National Access Programme funded by Science Foundation Ireland. He has successfully supervised six PhD students to completion and has six other PhD students in progress. Gerard has in excess of 72 scientific publications in the area of laser material interactions and 4 patent applications.

He has participated in the organisation of several scientific and technical meetings including Opto Ireland (Galway -2002, Dublin -2005), Photonics Ireland (Galway -2007, Malahide -2011) and chaired INSPIRE national Scientific Meeting (Cork 2010). His current research interests are in short pulse laser ablation; he has particular interests in laser ablation of thin films and laser material ambient interactions. He is also keen advocate for the transfer of laser technologies to industry; he is interested in applications where light is used to make, monitor and measure for cost effective advanced manufacturing.

## Contact details:

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