Institute of Photonics,
University of Strathclyde

Introduction to Lasers:
Science, Technology, Specifications and Applications

What- Continuing Professional Development short course.

When- 1/2 Day Monday 19th April 2010*
2 Days Tuesday 20th and Wednesday 21st April 2010*

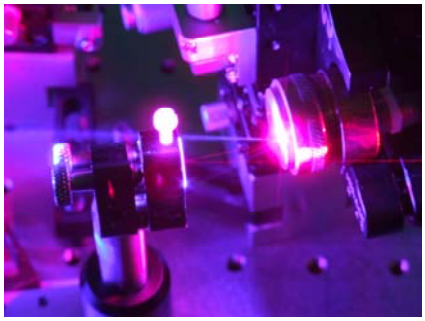
Where- Wolfson Centre, University of Strathclyde,
Glasgow city centre campus

Who The first 1/2 Day is a general introduction and is suitable for all members of staff. This may be taken alone or as the start of the whole 2 ½ days.
The 2 day course goes into greater depth, and would be suitable for non-specialist laser industry employees who have a basic understanding of lasers (and also for those who have previously attended the ½ day course). For example: operations, sales, marketing, quality, general management. It is not intended for R and D staff working in optics. It would be beneficial for mechanical, electronic or software R and D staff.

Why- To give all employees in the laser and photonics industry a full appreciation of the science, technology, products and applications that bring so much value to your companies and your customers.

Aims of the course
To give an understanding of:

- What a laser is
- How it works
- The different types of laser
- What attributes are important to different applications/customers
- How to read a spec sheet.
- The applications of lasers



To give an appreciation of:
The science behind the laser, the many types of laser, their applications, the many special formats of laser and what specifications are important to your customers and why.

Practical information regarding hotels, parking etc will be sent out to registrants.

Fees
1/2 Day Course is £125 per person and/or
2 Day Course is £250 per person per day
This includes refreshments, lunches and a paper copy of lecture notes.
A discounted rate is available to our Industrial Membership Programme or SU^2P partners.
To reserve places please contact simon.andrews@strath.ac.uk
Tel 0141 548 4120

Day One, Monday 19th April 2010 Overview of Lasers and Applications for all (*Half day*)			
Talk #	**Time**	**Subject**	**Components**
	1300	Introduction	• Overview of day – highlight some key points of all subjects below that follow to excite the audience!
1.1	**1305**	Light – some fundamentals	• The EM spectrum (radio, uwave,IR, vis, UV, Xray) • Wave-particle duality • Some common optical characteristics • Common light sources (incandescent, sun, light bulbs, Ne/ Na vapour, LEDs) – simple tech. explanation on origin of light in each • Lasers - special case how generated, difference from common light sources • Laser light characteristics e.g. coherence, spatial properties (e.g. collimation)
1.2	**1345**	History of the LASER	• Brief discussion of maser discovery • Maiman's ruby maser & laser • Early gas lasers • Brief overview of different lasers and reasons for the broad variety
1.3	**1405**	Laser resonator A guided tour	Discuss basic laser elements common to all lasers • Gain medium • Pump source • Resonator (- need for optical confinement -mirrors) Discuss actual laser operation • Population inversion • Stimulated emission • Optical feedback • Gain vs. cavity loss
	1520	Coffee	
1.4	**1535**	Special Laser Characteristics	Lasers which have capabilities that a layperson may not be aware of • Mode locked • Q switched etc • frequency conversion methods • Narrow linewidth lasers • real laser beam characteristics (collimation, divergence, multimode)
	1635 to 1700	Q and A	Day closes at 5pm

Day Two, Tuesday 20th April 2010			
Talk	**Time**	**Subject**	**Components**
2.1	0900	Outline of the days 2+3	• A plan of the days
2.2	0910	Introductory theory of laser operation	Operation of a laser starting from basic principles. Equations should be used as a 'tool' to explain dependence of phenomena on physical quantities. • Population inversion – Einstein equations • 4 and 3 level lasers; Stimulated emission; Rate equations • Laser resonator • Thermal lensing considerations • Longitudinal modes
2.3	1010	Geometrical optics	• Refraction / reflection • Ray diagrams • Prisms – discussion of dispersion • Diffraction • Simple optical systems • Optics used to collimate laser diodes and couple light into fibres • Aberrations likely to be encountered
	1110	Coffee	
2.4	1125	Practical Laser optics	Continuing from the laser resonator topics considered above but giving a more practical stance. Examples to consider: • Basic laser resonator components, early mirrors, dielectric mirrors, intracavity lens (inc. thermal) • Basic resonator designs– standing wave cavities e.g. plane parallel, concentric, example applications. • More advanced designs - Z-cavity, Brewster cut compensation, ring cavities • Intracavity frequency conversion – SHG/ OPO • Special intracavity elements –modelockers, cavity dumpers and Q-switches (AO and EO) –tuning and linewidth narrowing elements (BRF, etalon etc.) • Discuss laser alignment sensitivity • Cleanliness in manufacturing and effect of dust on performance • Workshop: aligning a HeNe laser – effect of mirror misalignment and dirt on performance. – group exercise
	1310	Lunch	
2.5	1340	Laser beam character-isation	Technical discussion on laser beam measurement including the following: • Gaussian beam focussing inc. far field divergence • Diffraction limited beam terminology TEM_{00} explained, other beam modes. Transverse modes discussed • M^2 measurement standard • Spot size measurement techniques – slit, camera etc. • Laser power / pulse energy measurement inc. discussion on types of laser power measurement heads – thermal / photodiode
2.6	1440	Different types of laser, more detailed	Examples of: • Solid-state lasers –examples (ruby, Nd:YAG, Ti sapphire, Yb based, Nd:glass) • Fibre lasers, theory, examples, advantages and disadvantages. • Semiconductor lasers, including edge emitting, VCSELS and VECSELS Briefly on dye, colour centre, gas and other lasers e.g. chemical
	1540	Coffee	
2.7	1555	The Ti:sapphire laser – a case study	Overview of the Ti:sapphire laser: history, characteristics, different laser types and applications • History • Characteristics that make it a favourable gain medium. • Examples of laser operating characteristics • Pumping techniques • Applications
	1700	Close	

Day three, Wednesday 21st April 2010			
Talk	**Time**	**Subject**	**Components**
3.1	0900	Laser terminology, acronyms and parameters explained	Detailed discussion of the laser terminology likely to be encountered: • Power, pulse-energy,wavelength, linewidth, pulsed, efficiency, wallplug efficiency,TEM00 • Reading spec sheets, what's important to customer and why. Using audience's products as examples
3.2	0945	Solid State laser geometries	A detailed discussion of different configurations and operating states of solid state lasers: • Pumping geometries and pump sources – flash lamp, solar, LED, laser diode, fibre coupled laser diode, side-pumping, end-pumping, grazing incidence, waveguide designs for pumping etc. • Practical solid-state laser alignment techniques • Active and passive modelocking • KLM laser alignment requirements and techniques • Incorporation of intracavity elements using extra folding sections etc. • Practical considerations for choosing particular pumping scheme and cavity design. Pros and cons of different layouts etc.
	1045	Coffee	
3.3a	1100	Current laser research	Selection of hot topics: • Motivation for work • Technical breakthroughs • Potential for future developments • Alternative applications Also discuss the main topics of current research using some of the IOP's work as examples
3.3b	1145	Lab visit	Visit labs to demonstrate some of the lasers discussed in 3.3a
	1245	Lunch	
3.4	1330	Frequency conversion techniques	Theory of operation (basic nonlinear optics) and practical consideration of techniques: • SHG generation in anisotropic crystals – 3 wave mixing mentioned for OPO • $\chi^{(3)}$ effects for higher harmonic generation mentioned • Extracavity and intracavity SHG • Resonant cavity extracavity SHG • Supercontinuum generation in PC fibres
3.5	1430	Laser applications	With a market context • medical uses – surgery, LASIK etc. • Military, • bio-imaging • R and D tools • telecoms, • Printing, • Laser machining
	1530	Coffee	
3.6	1545	Technology Readiness Levels.	To give appreciation of product lifecycle. From idea to mass production, university to industrial r and d.
3.7	1615	Pub Genius	10 things to remember to tell your mates in the pub.
	1630 to 1700	Q and A	

Course content and timings may be subject to minor changes.
The Institute of Photonics is a member of SUPA,
the Scottish Universities Physics Alliance