Opto-electronics - EE3OEL

Module Type		Taught		
Level		6	Credit Value	10
Programme(s) in which module is available		BEng: Electrical & Electronic Engineering; Communications Engineering BEng Electronic Engineering with Management Studies (last cohort)		
Involvement of Other Schools		None		
Resource Split		N/A		
Name of Module Co-ordinator		Prof Lin Zhang, Prof Ian Bennion		
Related Modules	Pre-requisites	EE2ESE or equivalent		
	Co-requisites	None		
	Prohibited Combinations	None		
Minimum and Maximum Intake Sizes		None		

Aims of the Module

- To provide a broad overview of updated optoelectronic principles, devices and applications.

The students studying this module will develop a basic understanding of the principles and practices of modern optoelectronic devices and their important functions for applications in optical communication, signal processing and sensing. Practical skills in optical fibre systems and measurement will also be acquired.

Summary of Content

Review of light properties - reflection and refraction, total internal reflection, plane waves, polarisation, concept of coherence, principle of superposition.
Light propagation in planar waveguides - light propagation in planar waveguide; waveguiding properties (numerical aperture, differential mode delay, mode structure) wave equations and solutions for slab waveguides, TE and TM modes, mode profiles.
Light propagation in optical fibre - optical fibre waveguides (step-index and graded-index fibres, single and multi mode fibres), waveguide mode properties, fibre transmission characteristics (optical losses in fibre – intrinsic and extrinsic loss, power budget calculation; fibre dispersion properties - modal dispersion, material dispersion, waveguide dispersion, total dispersion and dispersion management; non-linear effects – self phase modulation, pulse compression and solitons).
Laser fundamentals - emission and absorption of radiation, population inversion, optical feedback and gain, cavity modes, single-mode operation, frequency stabilisation, mode locking techniques, Q-switching, DBR and DFB lasers, class of non-semiconductor lasers.
Semiconductor lasers and light emitting diodes - semiconductor concepts - energy bands, semiconductor statistics; bandgap and E-k diagrams; optical emission from semiconductors - the p-n junction; principle of laser diode; heterostructure laser diodes; elementary laser diode characteristics; quantum well devices; vertical cavity surface emitting lasers; optical laser amplifiers; the light emitting diodes - surface emitter LEDs, edge emitter LEDs, superluminescent LEDs, LED characteristics, modulation bandwidths (electrical and optical).
Light modulation - electro-optic effect, electro-optic phase and amplitude modulators, acousto-optic effect, acousto-optic modulators, magneto-optic effect, Faraday effect, other type modulators.
Light detection - detector performance parameters, characteristics of noise, detection techniques (incoherent and coherent detections), thermal detectors, photodetectors, p-n junction and p-i-n photodiodes, speed of response, detector array devices.
Fibre optic components and applications - optical fibre directional couplers (coupling principle and power exchange, practical parameters of a coupler, fabrication techniques and applications), fibre polarisers and polarisation controllers, fibre Bragg gratings (coupled mode theory, spectral response, fabrication techniques, applications in fibre optic communication and sensing), single-mode optical fibre sensors (Mach-Zehnder interferometric sensors and fibre optic rotation sensors).

Summary of Methods and Frequency of Teaching Lectures 18 x 1 hour Tutorials 6 x 1 hour Laboratory 2 x 3 hours (Principles of Lasers and Optical Waveguiding) Private study 70 hours		
Summary of Methods of Assessment and Feedback (including formative feedback) Examination (60%) Continuous Assessment (40%) Feedback will be provided according to School guidelines. 1-to-1 feedback will be provided orally in laboratory sessions and by written comments on written reports. Generic feedback will be provided orally in class and via Blackboard.		
Module Outcomes – what the student should gain from successful completion of the module:	Learning and Teaching and Assessment Strategies to enable outcomes to be achieved and demonstrated	
	Learning and Teaching Methods	Assessment Methods
Knowledge and Understanding of • Basic understanding of the principles and practices of modern optoelectronic devices and their important functions for applications in optical communications, signal processing and sensing..	Lectures, tutorials, practicals	Examination and coursework
Intellectual Skills • Good comprehension ability of advanced subjects and technologies. • Evaluate and integrate information from a variety of sources. • Design and conduct new experiments..	Lectures, tutorials, practicals	Examination and coursework
Professional/Subject Specific Skills • Plan and conduct experiments in optoelectronics area. • Use appropriate test and measurement equipment.. • Competence in using theories and theoretical models • Prepare good technical report.	Lectures, tutorials, practicals	Examination and coursework
Transferable Skills • Problem solving. • Analytical skills. • Self-study. • Management of time and resources.	Lectures, tutorials, practicals	Examination and coursework
Introductory Learning Resources	Module information, tutorial material and generic feedback will be available on Blackboard	
Core Texts, reading list	S. O. Kasap, “Optoelectronics and Photonics – principles and Practices”, Prentice Hall, 2001 J Wilson and J F B Hawkes, "Optoelectronics: An Introduction", 3rd ed, Prentice Hall, 1998. S. F.G. Smith and T. A. King, Optics and Photonics – An Introduction, Wiley, 2000	
Specification completed by: Date	Geof Carpenter 22.7.09	