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GAILLIMH

NATIONAL UNIVERSITY OF IRELAND
GALWAY

SPRING EXAMINATIONS 2000

M.Sc. in BIOMEDICAL SCIENCE

EP514: Lasers and Applications II

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Time allowed : **Two** hours.

Answer three questions.

1. Answer **either** (a) **or** (b)

(a) Give an account of the different mechanisms by which laser radiation interacts with biological tissue. Distinguish between the effects of continuous and pulsed radiation, and indicate why the effects are wavelength-dependent. Describe in detail one technique which has been used to monitor the effects which take place during the laser-tissue interaction.

or

(b) Give an overview account of the different therapeutic and diagnostic applications of lasers in medicine, and indicate clearly the type of laser used in each of the applications you describe. Describe also the methods used for beam delivery to the treatment site. Describe one application in detail.

2. Give an account of the applications of low-power lasers in areas such as metrology, inspection, quality control, pollution monitoring, alignment.

What are the properties of laser beams which make them useful in these applications. Describe one application in detail.

3. List the thermo-physical material properties which are important in the application of high-power lasers for material processing and indicate how these parameters are related in an energy balance description of laser cutting/drilling and welding.

Explain the particular advantages which high-power lasers offer in material processing and give examples of the growing use of laser technology in the manufacture of medical devices.

4. Describe the physical processes which occur when a laser is used for (i) cutting, (ii) welding, and (iii) marking or engraving.. (Note that more than one method may be relevant in each case). Is a rise in temperature of the workpiece inevitable for such tasks ? What are the advantages of laser processing compared to conventional techniques? Illustrate your answer with examples, where possible .

5. Answer **two** of the following :

(a) Compare and contrast the techniques of infrared absorption spectroscopy and Raman spectroscopy, highlighting the advantages and disadvantages of each technique. Support your answer with examples of each technique in operation.

(b) Describe briefly two types of Resonance Raman spectroscopy. Demonstrate the advantages of using ultra violet excitation sources, illustrating your answer with specific examples.

(c) Derive the Stern-Volmer equation for a simple bimolecular quenching system under steady state conditions. Suggest an example of how this might be applied to biomedical sensors. The potential laser dye DXP exhibits a strong fluorescence at 530 nm when excited at 480 nm. This fluorescence is quenched by the addition of potassium iodide (KI).

The lifetime of DXP in methanol in the absence of KI was measured to be 3.54 nanoseconds. From the following data estimate the quenching rate k_q , the fluorescence rate k_f , and the Stern Volmer constant:

KI conc. (mol.dm ⁻³)	4×10^{-3}	12×10^{-3}	20×10^{-3}
I_0/I_f	1.06	1.23	1.38