UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

RESIT

For the following qualifications :-

M.Res

COURSE CODE	:	**PPP**
TITLE OF EXAMINATION	:	**Physics, Psychophysics and Physiology of Vision**
DATE	:	**26 February-1998**
TIME	:	**09.30**
TIME ALLOWED	:	**2 hours 30 minutes**

*Answer **four** questions in total. **Two** questions must be answered from section A, and **two** questions from section B. Each question is worth 25 marks. The total time allowed is two and a half hours.*

SECTION A

Attempt two questions from this section.

Question 1: <u>Physiology of cells in the visual pathway</u>

(a) Discuss briefly the relative merits of three techniques that have been used to study the receptive field properties of neurons in the visual cortex.

[10 marks]

(b) Outline the anatomy and physiology of visual processing stages up to and including V1 of the visual cortex. Your answer should include any differences that might arise from the receptive field profiles through different stages of processing.

[10 marks]

(c) Describe the major classes of retinal ganglion cells, and how the anatomy and physiology of these cells corresponds to their function in the processing of visual information.

[5 marks]

Question 2: <u>Visual information</u>

(a) Discuss in detail the image processing that takes place in the eye.

[15 marks]

(b) What is temporal binding? Explain how this process differs from the way in which visual information is processed in the central nervous system.

[10 marks]

[TURN OVER]

Question 3: Eye structure and movements

(a) Discuss the species specific advantages that may be gained by the differences in the anatomy and physiology of vertebrate and invertebrate eyes.

[15 marks]

(b) What functional similarities may be drawn between the vestibular ocular reflex and the optokinetic nystagmus.

[10 marks]

SECTION B

Attempt two questions from this section.

Question 4: Spatial vision

(a) Explain how a nonlinearity introduced into early visual processing could be exploited by the visual system and lead to the detection of the orientation of contrast envelopes.

[5 marks]

(b) What evidence supports the idea that the detection of contrast beats stems from an early (retinal) nonlinearity?

[5 marks]

(c) What evidence supports the idea that the detection of contrast beats stems from a later (cortical) nonlinearity.

[10 marks]

(d) On the balance of evidence, discuss the likely site of contrast beat detection.

[5 marks]

[CONTINUED]

Question 5: Binocular vision

(a) How does the perceived slant of a surface rotated about a vertical axis differ from the perceived slant of a surface rotated about a horizontal axis under binocular viewing conditions?

[5 marks]

(b) Briefly explain how the differences mentioned in your answer to question 5(a) may be explained by the idea that the visual system is able to exploit binocular differences in orientation.

[10 marks]

(c) Provide an explanation for Ogle's induced effect.

[10 marks]

Question 6: Image motion detection

(a) Derive from first principles a model of visual motion detection that uses the second-order derivatives of a low-pass Gaussian smoothing kernel.

[5 marks]

(b) Briefly explain how a model of motion detection based upon second-order derivatives differs from a model that is based upon first-order derivatives.

[5 marks]

(c) What is the aperture problem? Explain how the aperture problem might arise in images of natural scenes.

[5 marks]

(d) Explain how the aperture problem is manifested in one computational model of visual motion detection. What steps are required to solve for image velocity given that an aperture problem has occurred?

[5 marks]

(e) Discuss the empirical evidence that supports your answer to question 6(d).

[5 marks]

[END OF PAPER]