Ollscoil na hÉireann, Gaillimh GX 912
National University of Ireland, Galway

Semester II Examinations, 2002/2003

Exam Code(s)	3BS1, 3BS9, 3EL1, 3EL2, 3PT1, 3PT2
Exam(s)	3rd Science
Module Code(s)	EP339
Module(s)	EP339: Instrumentation
Paper No.	
Repeat Paper	Special Paper
External Examiner(s)	Professor E. Kennedy
Internal Examiner(s)	Professor S. G. Jennings
	Professor P. W. Walton
	Professor R. M. Redfern

Instructions: Answer THREE questions.

Duration	2 hrs
No. of Answer Books	1
Requirements:	
Handout	
MCQ	
Statistical Tables	
Graph Paper	
Log Graph Paper	
Other Material	
No. of Pages	3
Department(s)	Experimental Physics

EP339: Instrumentation

Answer THREE questions. Time allowed: TWO hours.

Q.1 Describe the principle of a linear variable differential transformer (LVDT). Explain why it is necessary to use it in conjunction with a phase sensitive demodulator and show, using detailed diagrams, how this works.

[10 marks]

Q.2 A deflection bridge is used to detect an out of balance situation when one or more of the impedances deviates from the normally balanced state. Calling the four impedances Z1, Z2, Z3 and Z4, and calling the voltage source Vs, derive an expression for the Thévenin output impedance.

[4 marks]

Derive the expression for the output voltage E_{th} (Thévenin voltage) for the bridge.

[4 marks]

A certain bridge has $V_s = 2$ Volts and four pure resistances of values 100, 100, 100 and 99 Ohms. Calculate the Thévenin resistance and the output voltage.

[2 marks]

Q.3 Sketch the model used to describe an electronic balance force measurement system employing high gain negative feedback but without modifying or interfering inputs.

[4 marks]

Use it to prove that the output voltage is given by the equation:

$$V_{out} = KK_AF_{in}/(1 + KK_AK_F)$$

where F_{in} = input force
K = sensitivity of the sensing element
K_A = amplifier gain
K_F = feedback gain.

[4 marks]

Explain the situation where the amplifier gain is made very large.

[1 mark]

Explain, without calculation, how the effect of a modifying input is changed when using high gain negative feedback.

[1 mark]

Q.4 Write short notes on three of the following topics: *[10 marks]*

A Optical aberrations
B Optical system design by ray tracing
C Catadioptric telescopes
D The photomultiplier tube
E Capacity sensors for displacement and humidity sensors

Q.5 Answer all parts.

(i) Describe, with the help of ray diagrams, the operation of simple telescopes, comparing the Galilean and Keplerian arrangements. What are the advantages and disadvantages of the two forms? *[3 marks]*

(ii) What are the advantages of replacing the single eye lens by a compound eyepiece? Discuss the lens arrangements and optics of one possible eyepiece suitable for a Keplerian Telescope. *[3 marks]*

(iii) Express the following telescope parameters in terms of the focal lengths and diameters of the lenses, and explain their significance:

magnification
speed
eye relief
exit pupil. *[2 marks]*

Evaluate the parameters for both a Keplerian telescope which has an objective diameter 100 mm and a focal length 250 mm, and for an eye lens of diameter 8 mm and a focal length of 5 mm. *[2 marks]*