

**OLLSCOIL NA hÉIREANN, CORCAIGH**  
THE NATIONAL UNIVERSITY OF IRELAND, CORK

COLÁISTE NA hOLLSCOILE, CORCAIGH  
UNIVERSITY COLLEGE, CORK

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**AUTUMN EXAMINATIONS, 2006**

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**B.E. (ELECTRICAL)**  
**B.E. (MICROELECTRONICS)**  
**M.ENG.SC. (MICROELECTRONICS)**  
**H.DIP. (MICROELECTRONICS)**

Medical Electronic Systems  
EE4012

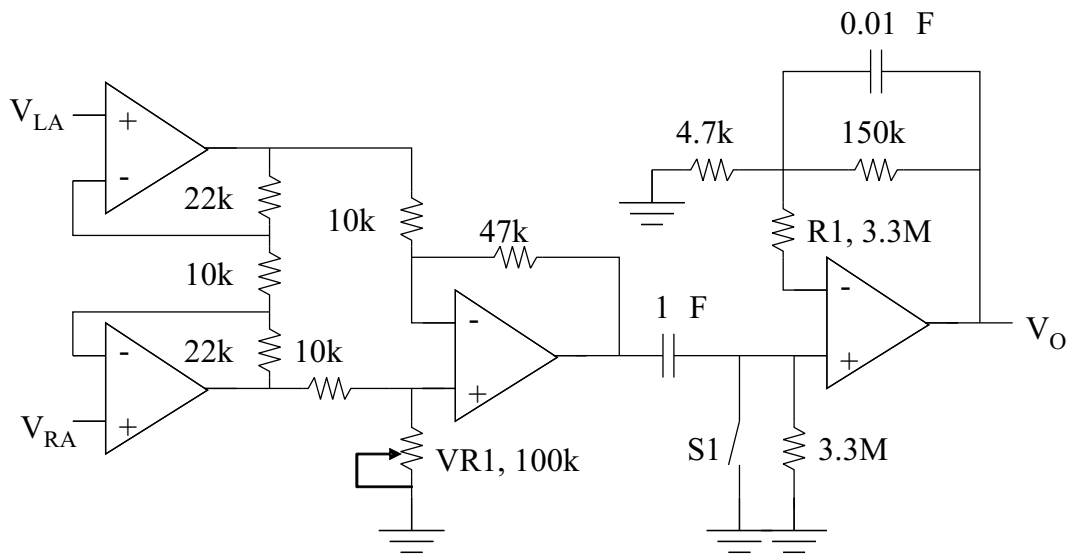
Professor Dr. U. Schwalke  
Professor P. J. Murphy  
Dr. R. Salerno-Kennedy  
Dr. K. McCarthy  
Dr. W.P. Marnane  
Dr. W. Wright  
Dr. G. Lightbody

Time Allowed: *3 hours*

Answer *five* questions.

All questions carry equal marks.  
The use of a Casio fx570w or fx570ms calculator is permitted.

1. (a) Describe briefly the components of the vascular system. [10 marks]  
(b) Define and describe briefly blood pressure and hypertension. [10 marks]
2. (a) The circuit diagram shows a simple ECG amplifier using ideal op-amps and with inputs from the left and right arms. If the variable resistor, VR1, is set to  $47k\Omega$  and switch S1 is open, determine and illustrate the frequency response of the circuit in the range 0.01Hz to 10kHz. [16 marks]



- (b) i. What is the purpose of VR1? [2 marks]
- ii. What is the purpose of S1? [2 marks]
3. (a) Briefly describe the most important signal properties of ECG and EEG signals including their amplitude and frequency ranges and how these affect the choice of suitable ADCs (Analog to Digital Converters) for ECG/EEG instrumentation. [10 marks]
- (b) Briefly define the following ECG-related terms, illustrating your definition by means of simplified diagrams:
- i. Einthoven Triangle. [2 marks]
  - ii. Wilson Resistor Network [2 marks]
  - iii. Lead I Connection [2 marks]
  - iv. Lead II Connection [2 marks]
  - v. Lead III Connection [2 marks]
4. (a) Give three examples of each of the following biomedical signals:
- i. Endogenous
  - ii. Exogenous [6 marks]
- (b) Define the following properties of a Discrete time random process:
- i. Wide Sense Stationary
  - ii. Ergodic Process [4 marks]
- (c) Using Diagrams and Text explain how the cross correlation function can be used to determine the heart rate from an ECG signal. [5 marks]
- (d)  $x(n)$  is the transmitted signal and it is received after a delay  $n_d$  corrupted by noise  $v(n)$  such that
- $$y(n) = x(n - n_d) + v(n)$$
- Show how the cross correlation function can be used to determine the delay  $n_d$ . [5 marks]

5. (a) In the Nervus EEG machine a FIR low pass filter is used to eliminate artefacts above 40Hz. Describe the method used to design this filter. [10 marks]

(b) Explain in detail how Fourier transforms and magnetic gradients are used in a typical MRI scanner to localise the signal source in 3-dimensions.

[10 marks]

6. Explain in detail what is meant by each of the following terms:

(a) Time Gain Compensation

(b) B-scan

(c) Mode conversion

(d) Near-Field distance

(e) Electronic phased array

[20 marks]

7. Explain in detail, how control engineering techniques can contribute to either of the following medical applications;

*either,*

(a) Functional electrical stimulation to restore muscle function, with application to unsupported standing, cardiovascular exercise and cycling.

*or,*

(b) Noninvasive monitoring and regulation in Type I Diabetic patients.

[20 marks]