# 2011 Paper 8 Question 6

**Digital Signal Processing**

(*a*) What can you say about the Fourier transform $X(f)$ if

    (*i*)   $x(t)$ is real;                                                                    [2 marks]

    (*ii*)  $x(t) = -x(-t)$?                                                                 [2 marks]

(*b*) Give the result of the Fourier transform $X(f) = \int_{-\infty}^{\infty} x(t)\,e^{-2\pi \mathrm{j} f t}\,\mathrm{d}t$, using Dirac's delta where appropriate, of

    (*i*)   $x(t) = 1$;                                                                   [1 mark]

    (*ii*)  $x(t) = \cos(2\pi t)$;                                                        [2 marks]

    (*iii*) $x(t) = \mathrm{rect}(t)$;                                                       [2 marks]

    (*iv*) $x(t) = [\frac{1}{2} + \frac{1}{2} \cdot \cos(2\pi t)] \cdot \mathrm{rect}(t)$.                              [3 marks]

(*c*) When is a random sequence $\{x_n\}$ called a "white noise" signal?    [2 marks]

(*d*) Consider an $n$-dimensional random vector variable **X**.

    (*i*)   How is its covariance matrix defined?                            [2 marks]

    (*ii*)  How can you change its representation without loss of information into a random vector of equal dimensionality in which all elements are mutually uncorrelated?                                      [4 marks]