40

UNIVERSITY OF SWAZILAND

MAIN EXAMINATION 2004/5

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: SIGNALS I

COURSE NUMBER: E342

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. Answer any FOUR (4) of the following five questions.
2. Each question carries 25 marks.

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

THIS PAPER CONTAINS SIX (6) PAGES INCLUDING THIS PAGE

QUESTION 1

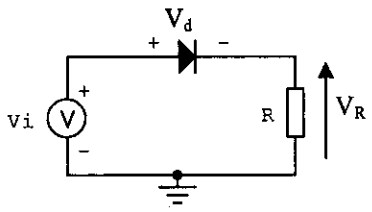

Fig. 1

In Fig 1 $V_i = 2\sin(\pi t)$

Sketch 2 periods of the following:

(a)	(i)	Input voltage V_i	[4 marks]
	(ii)	Voltage across diode, (V_a)	[4 marks]
	(iii)	Voltage across resistance R, V_R	[4 marks]
	(iv)	Classify the type of circuit in Fig. 1.	[3 marks]
(b)	(i)	Determine the average value of V_R	[5 marks]
	(ii)	Determine the RMS value for V_R.	[5 marks]

QUESTION 2

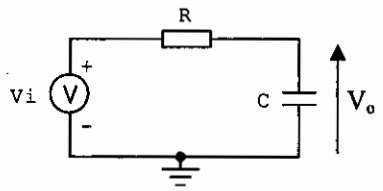

Fig. 2

Consider the circuit in Fig. 2.

(a) Determine its transfer function $\frac{v_o}{v_i} = G(j\omega)$ [5 marks]

(b) Determine and sketch the phase and amplitude characteristics of the circuit of Fig. 2. [10 marks]

(c) What type of filter does the figure represent? Elaborate on your response. [5 marks]

(d) Of what significance is the resistor and capacitor in the circuit? And what are they usually known as? [5 marks]

QUESTION 3

Given that

$$G(j\omega) = \frac{1}{1+j\omega RC} \qquad \text{(Eq. 1)}$$

and RC = 0.3 sec

(a) Compute the magnitude and phase of $G(j\omega)$ at $\omega = 1$. [6 marks]

(b) The square wave shown in Fig. 3 is applied to the system whose transfer function is given in Eq. 1. The square wave has a period 2π and amplitude unity.

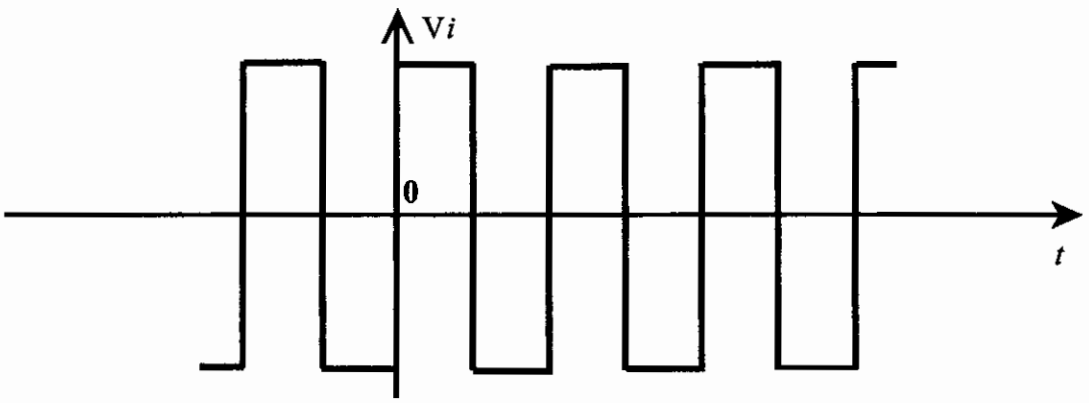

Fig. 3: Square wave with fundamental angular frequency 1 and amplitude 1.

(i) State whether the square wave is odd or even and how this will assist in determining the Fourier coefficients. [3 marks]

(ii) Sketch the output waveform after passing through the system described by Eq.1. [3 marks]

(iii) Obtain an expression for the Fourier Coefficients of the square wave. [6 marks]

(iv) Compute the **first three** Fourier coefficients. [3 marks]

(v) Evaluate the gain and phase changes to these first three Fourier components as they pass through the system in Eq.1. [4 marks]

QUESTION 4

(a) Determine whether the following signal processing operations are linear or non-linear.

(i) $y(t) = 2x(t) + d\dfrac{x(t)}{dt}$ [2 marks]

(ii) $y(t) = 3 + \int 5x(t)dt$ [2 marks]

(iii) $y(t) = 4x^2(t)$ [2 marks]

(b) Sketch the graphs of the following signals and determine the magnitude and period of each signal.

(i) $x(t) = 2\cos 2\pi t + 3\cos 4\pi t$ [3 marks]

(ii) $x(t) = |\sin 5\pi t|$ [3 marks]

(c) (i) Describe energy and power signals and give an example of each. [6 marks]

(ii) Find the average power developed across a 1 Ω resistor by the voltage signal:

$$v(t) = 2 + \cos t - \frac{2}{3}\sin 2t + \frac{1}{2}\cos 3t$$

(Hint: use Parseval's theorem)

[7 marks]

QUESTION 5

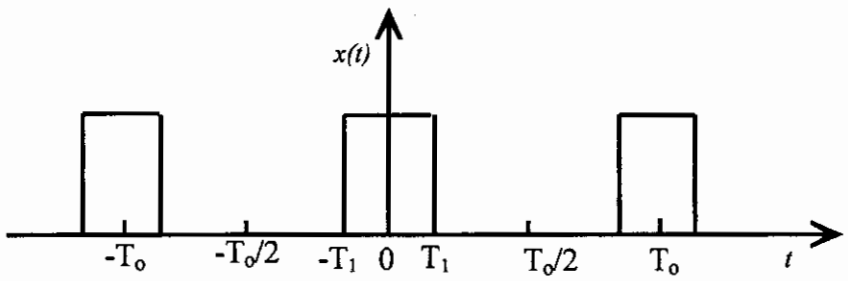

Fig. 4

A periodic square wave shown in Fig. 4 above is defined as:

$$x(t) = \begin{cases} 1, & |t| < T_1 \\ 0, & T_1 < |t| < \dfrac{T_o}{2} \end{cases}$$

Determine the exponential Fourier series expansion of the wave.

[25 marks]