1[illegible]5 Electrotechnology - Lecture Notes

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Chapter 1

About this document

This document contains all the lecture notes of the 1BA5 of Computer Science, BA., Trinity College, Dublin, as lectured by Dr. O'Nuallain. The notes are a literal representation of the notes given in class, including diagrams, graphs and circuits.

Note that the course overview in the first chapter is not actually correct. This is because the course structure was changed halfway the course. But since this document is a direct copy of the notes, this inconsistency is still visible in this document. Never mind ;-)

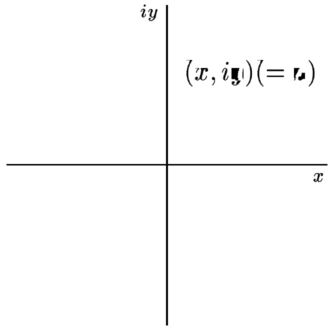
This document has been created using Latex for the typesetting, GNUPlot for the graphs and M4

2.5 Section V - Electric Circuit Components

1. Resistor
2. Capacitor
3. Inductor
4. Transformer
5. Semiconductor diodes and transistors

2.6 Section VI - Electric Circuits

1. D.C. circuit


iy
(x, iy)(= z)
x

3.1. The oordinates

Let $x = r$ co Θ, $y = r$ in Θ; $r = |z|$, then

$$
\begin{aligned}
z &= x + iy = r \,\mathrm{co}\ \Theta + ir\ \mathrm{in}\,\Theta \\
&= r(\mathrm{co}\ \Theta \ldots
\end{aligned}
$$

3.3. Multipli ation of a matrix by a s alar

A + A + A + A + A = 5A.

Given a real number k $\mathbb{R}$ and a matrix (a_{ij}) we define kA to be the m×n matrix where the entrie are (ka_{ij}).

3.3.7 Properties of s alar multipli ation

k $\mathbb{R}$, A, B are m×n matrice

1. lo ure: kA i an m×n matrix
2. Di tributive: $k(\mathrm{A} + \mathrm{B}) = k\mathrm{A} + k\mathrm{B}$ (*Also:* $(k_1 + k_2)\mathrm{A} = k_1\mathrm{A} + k_2\mathrm{A}$)

. A ociative: $k_1(k_2\mathrm{A}) = (k_1k_2)\mathrm{A}$

4. $1 \cdot \mathrm{A} = \mathrm{A}$

3.3.8 Matrix multipli ation

If A in m x **n** and B i **n** x k, multiplication of A and B goe a follow :

Example A: 2 x , B: x

A $\begin{pmatrix} 1 & 2 & 4 \\ 0 & 1 & -5 \end{pmatrix}$, B $\begin{pmatrix} 6 & -1 & \\ 0 & 2 & 4 \\ 1 & 1 & - \end{pmatrix}$, then:

AB =

$\frac{\mathrm{d}}{\mathrm{d}}$

Thi equation de cribe the o cillation of a body on a pring where m i the ma of the body, C the damping con tant, k the pring modulu at re t.
$F(t$

Note If $f(x,y)$ is homogeneous, then $f = (\frac{x}{x}, \frac{y}{x}) = f(1, \frac{y}{x}) = f(1, v)$

The equation then becomes $x\frac{\mathrm{d}v}{\mathrm{d}x} + v = f(1, v)$, which can be written in separable form:

$\frac{\mathrm{d}v}{\mathrm{d}x} = \frac{1}{x}\left\{f(1, v) - v\right\}$

which can be solved using previous methods.

Example 8

Application II - the RC circuit

Setup:

hapter 4

ys s v w

For a di cu ion on the phy ic ection, ee:

> Senior Phy ic
> by George Porter

4.1 art A - Mechanics

Example It takes 10 times the force to move object A from rest as it does to move object B (in the same environment). Hence the mass of object A is 10 times that of object B.

Example

Law II

When a re ultant external force act on a body, the rate of change of the body' momentum i proportional to the force and take place in the direction of the force.

Law III

In any interaction between two bodie A and B, the force exerted by A on B i equal in magnitude

Why with a con tant acceleration and not with con tant velocity

Not Read

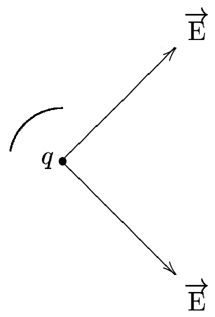
[redacted]apter [redacted]

[redacted]l tr

[redacted].1.3 Definitions

W

When charge move they exert a force on one another. Another way of looking at thi phenomenon



$\vec{E}$
q
$\vec{E}$

Diagram

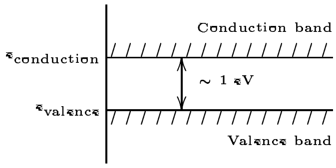
(0) B_a $B_{\mathfrak{b}}$ (x)

$\prec$ $_x$ $\succ$

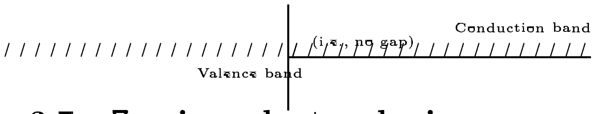
N

Chapter 6

Semi-conductors



Conductors



.3.2 Semi- ondu tor doping

A proce known a dopin

Chapter 7

Electric Circuit Components

7.1 Preamble

7.1.1 Current

Definition The **current** $i(t$

.2 Th sistor

A re i tor i a two-terminal element which impede the flow of electric current through it by converting ome of the electrical energy into heat. The degree to which it impede the current flow i characterized by it' re i tance. Every material po e e thi property to ome extent. The relation hip between the terminal voltage of a re i tor and the current flowing through it i given by Ohm' Law:

$$v(t) = Ri(t)$$

Thi (t)mp

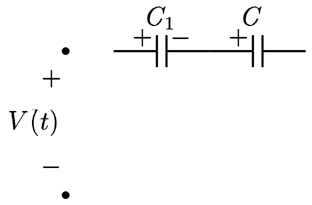
$$p_{\text{wire}} = \frac{V(t)}{R_{\text{wire}}}$$

which eem to contradict the econd ugge tion above. However, it doe n't. $V(t)$ i the potential difference between the po itive and negative terminal , i.e. acro the wi

7.2.2 The Potential Divider

An important application of re i tor i the potential divider. It i u ed to obtain a

$$C = \epsilon A$$


C_1
C
+
−
+
+
$V(t)$
−


V_1

$$\begin{aligned} \text{Let} \quad V(t) &= V_m \,\mathrm{co}\ (\omega t+\varphi)\\ i(t) &= c\frac{\mathrm{d}v}{\mathrm{d}t}\\ \text{o} \quad i(t) &= -C_\omega V_m\ \ \mathrm{in}(\omega t+\varphi)\\ &= C_\omega V_m \,\mathrm{co}\ (\omega t+\varphi+\tfrac{\pi}{2})\\ &= I_m\,\mathrm{co}\ (\omega t+\varphi+\tfrac{\pi}{2})\end{aligned}$$

Diagramatically:

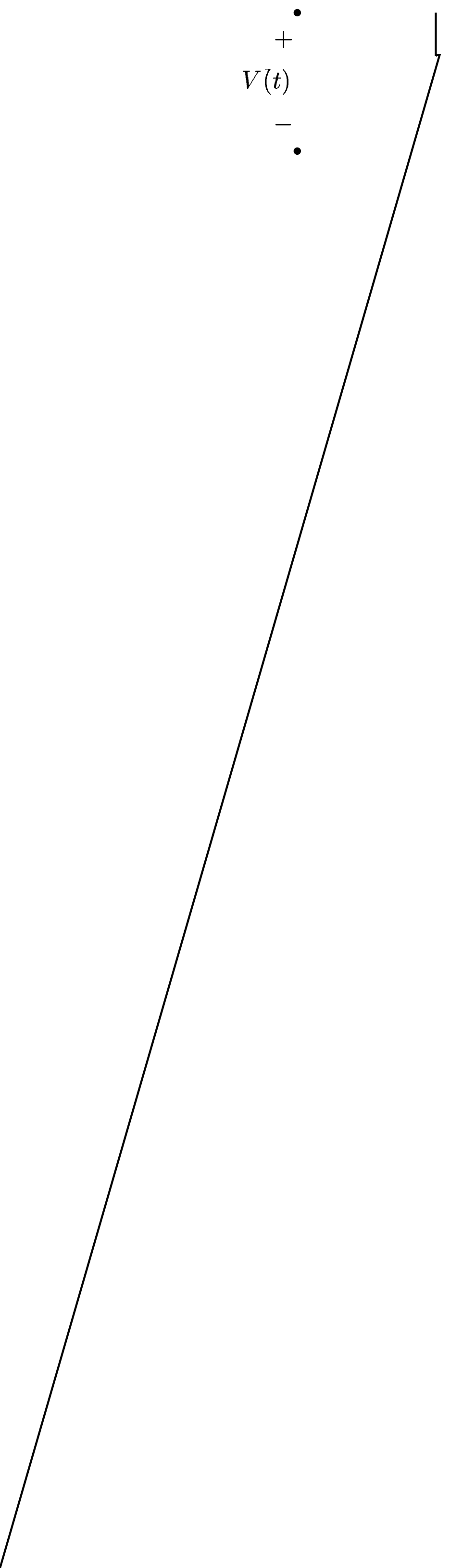
V_m

throughout.

Then: $L_T = \frac{\mathrm{d}i(t)}{\mathrm{d}t} = L_1 \frac{\mathrm{d}i(t)}{\mathrm{d}t} + L_2 \frac{\mathrm{d}i(t)}{\mathrm{d}t} + \cdots L_n \frac{\mathrm{d}i(t)}{\mathrm{d}t} \therefore L_T = L_1 + L_2 + \cdots + L_n$

Inductors in parallel

on ider the following etup:



The forward characteri

.6 Transformers

One of the main ad

In practi e ource are not id

Convention

You will have noticed the assignment of the positive and negative terminals to the resistor in the above circuit. We note that electrical current is deemed to flow from the positive terminal of the source to the ne

to a

$$V_{NW} = V_s - I \quad s_V$$
$$V_{NW} = (I_s - I) \quad s_I$$

For the e two equa

$$
\begin{aligned}
V(t) &= V_m \,\mathrm{co}\,(\omega t + \varphi); V_m \quad \mathbb{R} \\
&= \mathrm{Re}\,\{V_m e^{j(\omega t + \varphi)}\} \text{ (from Euler' formula } (j = \sqrt{-1})) \\
&= \mathrm{Re}\,\{V_m e^{j\varphi} e^{j\omega t}\} \\
&= \mathrm{Re}\,\{\hat{\mathrm{V}} e^{j\omega t}\}
\end{aligned}
$$

$\hat{\mathrm{V}} = V_m e^{j\varphi}$ i referred to a a *phasor*.

For implicity, we can ignore the Re{ } notation and imply de cribe the upply voltage in the above circuit a $V(t) =$

Not■ The unit a igned to all impedance i the Ohm ('Ω').

8. Imp■danc■ S■ri■s and arall■l

It i ■a ily hown from the formulae for a /a

. .1 Pro edure to get Thévnin's quivalent Cir uit

1. Remove the load impedance and mark the terminal a and b

2. alculate R_{TH} or $_{TH}$ by etting all

An wer (the Thévnin e

$$
\begin{aligned}
{}_{TH} &= 500\Omega || - j1500\Omega \\
&= \frac{(500\angle 0^\circ)(1500\angle - 90^\circ)}{500 - j1500} \\
&= \frac{7.5 \cdot 10^5 \angle - 90^\circ}{1581\angle - 71.57^\circ} \\
&= 474.8\angle - 18.4^\circ\ \Omega \\
&= 450 - j150\Omega \text{ (ee polapreentation of complex num}
\end{aligned}
$$

Example (D. .) Find the current through the 2Ω re i

[illegible].1[illegible].2 Nodal Analysis

Procedure

1. Define all nodes using independent variables taking [illegible] a reference ([illegible])

2. A

[illegible].11.[illegible] Po er Fa tor

The power factor p.f

From K. .L.:

$\hat{\mathrm{i}} = \hat{\mathrm{i}_{\mathrm{c}}} + \hat{\mathrm{i}_{\mathrm{L}}}$

Al o:

$\hat{\mathrm{i}_{\mathrm{c}}} = j\omega C\hat{\mathrm{V}}$

$$\hat{\mathrm{i}_{\mathrm{L}}} = \frac{\hat{\mathrm{V}}}{R + j\omega L}$$

(Multiply by complex conjugute of the deno

8.1 The maximum power tranfer theorem

o

$R_L = R_T \therefore V_L = \dfrac{V_T}{2}$

$P_{L,matched} = \dfrac{V_T^2}{4R_L} = 0.0\ \ 125V_T^2$

Hence the power increa e with impedance matching would be $\dfrac{0.0\ \ 125 - 0.0278}{0.08125} =$

From the plot of i v . f we note there i a range of frequencie about f_s where the current i near it maximum. The e frequencie $(f_1, f_2$

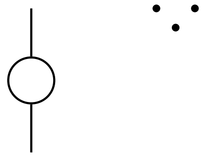
[redacted]apter 9

Tr ns nt [redacted]n lys s of [redacted]C n [redacted]L r u ts

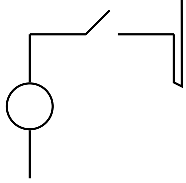
Tran

9.1.1 Charging phase of an RC ir uit

Apply K



Sparking at the witch can be prevented by having the circuit et up a :



In x

A.

Momentum, 2