**電子與電路學**

-電路(Electric Circuit)+電子元件+電子線路(Electronic Circuit)

-Basic Concept

-Electric Circuit

-Voltage, Current, Power

-Signal: AC, DC, RMS(Root Mean Square)

**<DEF> Electric Circuit**

A GRAPH - a collection of Vertices(端點) and Edges(連接)

whereby every edge contains excatly one electric component

and, every vertex has a specific electric potent where one of them is defined as 0 volt, i.e. Ground

-measurement

-Vertex → Electric Potential(V)(電壓): Potential Energy(位能)

-Edges → Current(I)(電流)

-Electric Power(P)(電力):

-能量以光速前進而非電子

**<DEF> Ohm's Law**

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-R (resistor), ρ(resistivity)(電阻率), L(電阻長度), A(電阻截面積)

-

-E(electric feild strength), J(current density)

-宏觀(macroscopic)(電磁波長λ>>系統大小): R=V/I

-微觀(microscopic)(電磁波長λ<<系統大小): E=ρJ

**<Syntax>**

v(t) / i(t): small → time varing value

V / I: capital → average of v(t)/i(t)

vA / iA : capital → reference with 0V/0A

va / ia: small → reference with VA/IA → (va(t)-VA)/(ia(t)-IA)

**<DEF>Root Mean Square**

-Basic Electric Component

-Active Component

-Passive Component

**<DEF> Active Component**

Producer/Generator of signal power(訊號能量)

-Signal type

|  |  |  |  |
| --- | --- | --- | --- |
|  | Voltage | Current |  |
| independent | +/-: DC  ~: AC |  | Signal Characteristic do not depend on other electric measurment in circuit |
| dependent | +/-: DC  ~: AC |  | ------ [depend component] |

**<DEF>Passive Component**

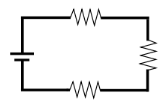
Consume signal power

-Resistor(R)(電阻): 能量耗損

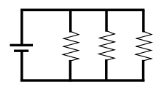
-v-i characteristic: Ohm**'**s Law →

-Thermal effect(熱效應): Resisters produce heat when operating

-Thermal run away

 -connection:

-Serial(串聯): Ri+Rj



-Parallel(並聯): Ri//Rj

-Capacitor(C)(電容): 位能保持與產生 +─┤├─-

-Electric storage: charge(充電)/discharge(放電)

-Insulator(絕緣) medium/Air

-v-i characteristic:

-C(Capacitance)(電容量), Q(電量)

-Inductance(L)(電感)(線圈): 動能保持與產生

-Electro-magnetic inductance(電磁感應)

-電介質/Air

-v-i characteristic:

-L(電感值)

-Dual relation of v-i characteristic: Capacitor ←→ Inductance

**<CONCEPT>Linearity**

Law of Superposition(疊加原理): 訊號可以由不同訊號源經疊加產生

**<How to SOLVE an Electric Circuit>**

-Complete/Full solution: find ALL the voltage (at each vertex) and current (through each edge) values in the circuit

-Partial Solution: find the voltage and current values at Input Node and Output Node

**<DEF>Kirchhoff's Voltage & Current Law (KVL & KCL)**

-KVL: Algebraic sum of all Voltage differences between the nodes in a Closed Loop of a circuit should always be ZERO

-closed loop: a path from one node back to itself without traversing any edge more than once

-node voltage as potential energy of electric charges

-Conservation of Energy(能量守恆定律)

-(+v): same direction as flow voltage

(- v): opposite direction to flow voltage

-Use Rule:

-Identify all Nodes in the circuit

-start with GROUND Node

-other end of every component is a distinct node

-repeat the procedure until all components have been visited and all nodes have been marked

-assign every node (except Ground) with a distinct node voltage

-Identify all Loops in the circuit

-start with GROUND Node (or Upper-Left Node)

-identify a loop by traversing components connected to the previous node until going back to the original node (in clockwise direction)

-identify another new loop by including at least one new component until no new component can be included

-Identify voltage difference across each component

-assign Polarity(極性) which end node is positive

-start from Upper-Left Node which is likely to be the node with highest potential

-name the voltage differences using end nodes or components

-v(+node)(-node) or v(component)

-write Circuit Equations using KVL

-one equation for every loop along loop circuit direction

-KCL: Algebraic sum of all Currents flow into (+ve) and out of (-ve) a node in a circuit should always be ZERO

-no electric charges shall be generated or destroyed in a circuit node

-Conservation of electric charges

-Use Rule:

-Identify all Nodes in the circuit

-Identify voltage difference across each component

-write Circuit Equations using KCL

-one equation for every node

**<DEF>Open Circuit & Short Circuit**

-Open Circuit(O.C.斷路)

-NULL Condition:

-Short Circuit(S.C.短路)

-NULL Condition:

-A and B are NOT distinguishable nodes → merge into one node

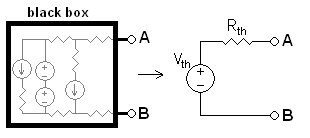
**<CONCEPT>Equivalent Circuit(等效線路)**

Simplify the process of solving EE (Linear) circuit

-Circuit Port: a Pair of distinct circuit nodes

-One Port Circuit

-Thevinin Equivalent Circuit: for any linear circuit, the electric characteristic (v-i characteristic) of a specific port can always be modeled as an Ideal Voltage Source (vth) and a SERIALLY connected passive element with Impedance(阻抗) (Zth) or Resistor (Rth)



-short circuit: vAB=0 → R=0 ; open circuit: iAB=0 → R→∞

KVL: (open circuit) vth-vR(=0)-vAB(=voc)=0 → vth-voc=0 → vth=voc

(short circuit) vth-vR-vAB(=0)=0 →vth=voc=vR=Rthisc →Rth= voc/isc

-really practical way

-calculate vth: using Voltage Divider Formula

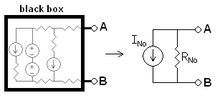
-calculate Rth: estimate internal impedance

-turn off all internal signal source

-ideal voltage source → short circuit

-ideal current source → open circuit

-Norton Equivalent Circuit: for any linear circuit, the electric characteristic (v-i characteristic) of a specific port can always be modeled as an Ideal Current Source (ino) and a PARALLELY connected passive element with Admittance (Yno) or Conductance(電導) (Gno)



**<CONCEPT>Ideal Voltage/Current Source**

-Ideal Voltage Source

-No internal loss

-No internal impedance/resistor → Rth=0

-Ideal Current Source

-No internal loss

-No internal admittance/conductance → Gno=0

**<DEF>Transfer Function**

always quantities of input vs. output signal

Four possible combinations depending on choice of input/output quantities (voltage/current)

Specify the voltage/current condition (O.C./S.C.) for measuring Transfer Function

-Voltage Ratio (Voltage Gain):

-Current Ratio (Current Gain)

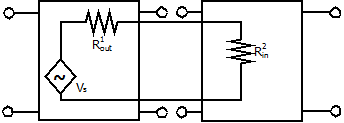
-Trans-Resistance

-Trans-Conductance

**<CONCEPT>Coupling(偶合)**

-according to the electric characteristic of input/output signal

-Voltage Coupling

 -Thevinin Equiv.

-Current Coupling

-Norton Equiv.

-according to the characteristic of transferred signal

-DC Coupling: including DC and AC component

-AC Coupling: including AC component only