背景：电路(电子)，电磁

※軟体：PSIM

負載 = ex. 燈泡

這門課會教的

同心協力供电

第一個电力公司是
為了負載建立的

Power System Analysis

供電=用電

電 < 直流电 (0 Hz) 愛迪生
電 < 交流电 (60Hz / 50Hz) 特斯拉(T)

↓ 电力系統的範本

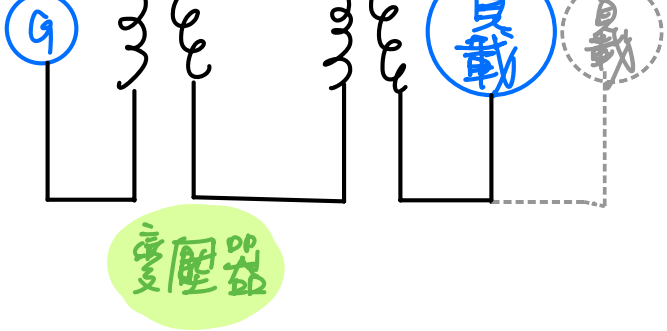
期中期末各佔50%

Arthur R. Bergen

授課：侯中權 博士

(Prof. Chung-Chuan Hou)


G
負載
負載


G
負載
負載
變壓器

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1.0簡介(Introduction)

1.1電能(Electric Energy)

1.2化石燃料電廠(Fossil-Fuel Plant)

1.3核能電廠(Nuclear Power Plant)

1.4水力電廠(Hydroelectric Power Plant)

1.5其他能源(Other Energy Sources)

1.6輸電與配電系統(Transmission and Distribution Systems)

(The Deregulated Electric Power Industry)

2.基本原理(Basic Principles)

2.0簡介(Introduction)

2.1供應單埠的複數功率(Complex Power Supplied to a One-Port)

2.2複數功率守恆(Conservation of Complex Power)

2.3平衡三相(Balanced Three-Phase)

2.4單相分析(Per Phase Analysis)

2.5平衡三相功率(Balanced Three-Phase Power)

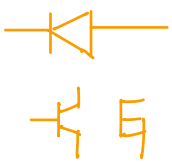
2.6複數功率傳輸(短程)(Complex Power Transmission: Short Line)

2.7複數功率傳輸(輻射線路)(Complex Power Transmission: Radial Line)

2.8結論與習題(Summary)

以負載角度來看

負載
- 被動 (線性) 不會改變頻率
  - $V=IR$ (R) 簡單，手機耗能產熱
  - $V=L\frac{di}{dt}$ (L)
  - $i=C\frac{dv}{dt}$ (C)
  - 不消耗能量，是儲存能量 (會發熱是因為寄生電阻，理想上不會發熱)。
- 主動 (非線性)



電力電子：電能轉換

直流 0 Hz

交流 60Hz

① AC → DC

② DC → DC

③ DC → AC

④ AC → AC

＊變壓器是線性元件，不會改變頻率

直流電和交流電是垂直正交

正交性

① 垂直

② Fourier 直流，交流 $\sin nwt$ $\cos nwt$

③ $1, X, X^2, \cdots$

距離拉長就會變很複雜

3.輸電線參數(Transmission-Line Parameters)

3.0簡介(Introduction)

3.1磁學回顧(Review of Magnetics)

$V = L\frac{di}{dt} = Lsi$

$\frac{d\sin\omega t}{d\omega t} \times \frac{d\omega t}{dt} = \cos\omega t \times \omega$

$j\omega \sin\omega t$

3.2無限長直電線的磁通鏈(Flux Linkages of Infinite Straight Wire)

3.3多導體情況下的磁通鏈(Flux Linkages of Multi-Conductors)

3.4捆束導體(Conductor Bundling)

3.5移位(Transposition)

3.6電場回顧(Review of Electric Fields)

3.7線路電容(Line Capacitance)

3.8典型參數值(Typical Parameter Values)

3.9結論與習題(Summary)

4.輸電線模型(Transmission-Line Modeling)

4.0簡介(Introduction)

4.1端點處V,I關係的推導(Derivation of Terminal V,I Relations)

4.2輸電線上的電波(Waves on Transmission Lines)

4.3傳輸矩陣(Transmission Matrix)

4.4等效集總電路(Lumped-Circuit Equivalent)

4.5簡化模型(Simplified Models)

4.6複數功率傳輸(長程或中程線路)(Complex Power Transmission: Long or Medium Lines)

4.7線路的功率處理容量(Power-Handling Capability of Lines)

4.8結論與習題(Summary)

5.變壓器模型與標么系統(Transformer Modeling and The Per Unit System)

5.0簡介(Introduction)

5.1單相變壓器模型(Single-Phase Transformer Model)

5.2三相變壓器接法(Three-Phase Transformer Connections)

5.3單相分析(Per Phase Analysis)

5.4正規系統(Normal Systems)

5.5標么正規化(Per Unit Normalization)

5.6三相標么物理量(Per Unit Three-Phase Quantities)

5.7基準的改變(Change of Base)

5.8正規系統的標么分析(Per Unit Analysis of Normal System)

5.9電壓與相角控制用的調節變壓器(Regulating Transformers for Voltage and Phase Angle Control)

5.10輸電線與變壓器(Transmission Line and Transformer)

5.11結論與習題(Summary)

發电機

6.電力潮流分析(Power Flow Analysis)

6.0簡介(Introduction)

6.1電力潮流方程式(Power Flow Equations)

6.2電力潮流問題(The Power Flow Problem)

6.3利用高斯疊代法求解(Solution by Gauss Iteration)

6.4通用疊代法(More General Iteration Scheme)

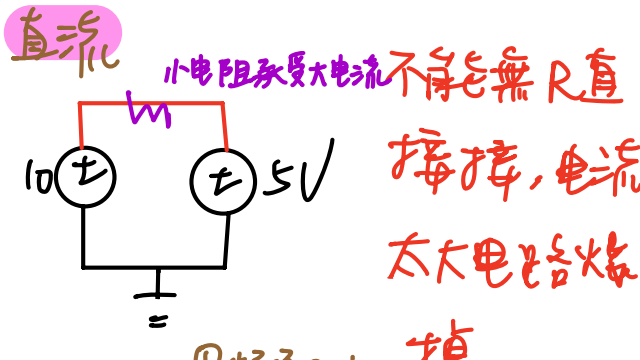
6.5牛頓-拉夫生疊代法(Newton-Raphson Iteration)

6.6應用於電力潮流方程式(Application to Power Flow Equations)

6.7分解電力潮流(Decoupled Power Flow)

6.8控制上的含意(Control Implications)

6.9結論與習題(Summary)



7.電力系統的經濟操作

(Economic Operation of Power System)

7.0簡介(Introduction)

7.1經濟調度問題的形成)(Formulation of the Economic Dispatch Problem)

7.2古典經濟調度(忽略線路損失) (Classical Economic Dispatch (Line Losses Neglected))

7.3考慮發電機極限(Generator Limits Included)

7.4考慮線路損失(Line Losses Considered)

7.5償罰因數的計算(方法1)(Calculation of Penalty Factors: Method I)

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8.1古典機械描述(Classical Machine Description)

8.2電壓的產生(Voltage Generation)

8.3開路電壓(Open-Circuit Voltage)

8.4電樞反應(Armature Reaction)

8.5端電壓(Terminal Voltage)

8.6發電機送出的功率(Power Delivered by Generator)

8.7使發電機同步於無限滙流排(Synchronizing Generator to an Infinite Bus)

8.8同步電容器(Synchronous Condensor)

8.9結論與習題(Summary)

Role of Synchronous Machine Excitation in Controlling Reactive Power

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9.0簡介(Introduction)

9.1模型(Model)

9.2能量平衡(Energy Balance)

9.3搖擺方程式的線性化(Linearization of Swing Equation)

9.4非線性搖擺方程式的解(Solution of Nonlinear Swing Equation)

9.5其他應用(Other Applications)

9.6擴展至兩個電機的情形(Extension to Two-Machine Case)

9.7多電機應用(Multi-Machine Application)

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10.2應用於同步電機(Application to Synchronous Machine)
10.3帕克變換(The Park Transformation)
10.4帕克電壓方程式(Park's Voltage Equation)
10.5帕克機械方程式(Park's Mechanical Equation)
10.6電路模型(Circuit Model)
10.7瞬間功率輸出(Instantaneous Power Output)
10.8應用(Applications)
10.9同步操作(Synchronous Operation)
10.10定態模型(Steady-State Model)
10.11簡化動態模型(Simplified Dynamic Model)
10.12發電機接至無限滙流排(線性模型)(Generator Connected to Infinite Bus: Linear Model)
10.13結論與習題(Summary)

11.電壓控制系統(Voltage Control System)

11.0簡介(Introduction)

11.1激磁器系統方塊圖(Exciter System Block Diagram)

11.2發電機模型(Generator Models)

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11.4電壓調整(Voltage Regulation)

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13.7線間故障的序網路連接(Sequence Networks Connections for Line-line Fault)
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13.12序網路的輸電線模型(Sequence Representation of Transmission Line)
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14.3阻抗(測距)電驛(Impedance (Distance) Relays)

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14.5發電機的差動保護(Differential Protection of Generators)

14.6變壓器的差動保護(Differential Protection of Transformer)

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14.8保護區的重疊(Overlapping Zones of Protection)

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