

### 錯誤控制碼理論教學計畫表

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|--------|--|
| 科目代碼   | CSIE58200  |
| 科目名稱   | 錯誤控制碼理論 (ERROR CONTROL CODING)   |
| 必選修    | 選修   |
| 授課老師   | 楊慶隆  |
| 開課班級   | 資工所 碩士生、博士生  |
| 學分數    | 3  |
| 每週授課時數 | 3  |
| 校內分機   | 4025   |
| 教師電子郵件 | cnyang@mail.ndhu.edu.tw  |
| 教師辦公室  | 工 C314   |
| 會談時間   | 星期四 10:00~12:00  |
| 課程助教   | 張仕翰、蘇嘉興  |
| 助教電子郵件 | {m9521033、m9521025}@em95.ndhu.edu.tw   |
| 助教工作項目 | 作業解答、批改考卷  |
| 課程目標   | 探討數位通道及計算機系統的錯誤更正及檢測，奠定日後研究網路、多媒體、儲存系統中錯誤控制的理論基礎。  |
| 教學方法   | 1. 講授及討論為主 2. 論文報告   |
| 教學評量   | 期中考(1/2)、論文報告 (1/2)  |
| 課堂教材   | Error Control Coding, 2/E, by Shu Lin and Daniel J. Costello, Prentice-Hall, 2005. ISBN: 0-13-042672-5.            |
| 其他教材   | Error-Control Coding for Computer Systems, by T. R. Rao and E. Fujiwara, Prentice-Hall, 1988. ISBN: 0-13-283953-9. |
| 作業備註   |  |
| 其他標題   |  |
| 其他內容   |  |

## 教學進度規劃

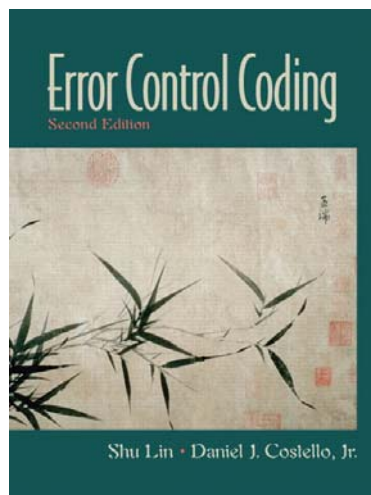
| 週次 | 日期    | 進度   | 重要事項                         |
|----|-------|--|------------------------------|
| 1  | 9/18  | Overview of this course. Syllabus.                 | 原書內容甚多，上課不以書本章節為順序，而以課程議題為主。 |
| 2  | 10/2  | 課程議題(一): 錯誤控制碼理論基礎                                 |                              |
| 3  | 10/9  | Algebra, Galois Field, ...                         |                              |
| 4  | 10/16 |  |                              |
| 5  | 10/23 | 課程議題(二): 線性區塊碼                                     |                              |
| 6  | 10/30 | (1) Cyclic code (2) BCH code (3) Reed-Solomon code |                              |
| 7  | 11/6  |  |                              |
| 8  | 11/13 | 課程議題(三): 迴旋碼                                       |                              |
| 9  | 11/20 | (1) Viterbi Decoding (2) Sequential Decoding       |                              |
| 10 | 11/27 |  |                              |
| 11 | 12/4  | 課程議題(四): 非線性碼<br>(1) Unidirectional errors         |                              |
| 12 | 12/11 | <b>MID EXAM</b>                                    |                              |
| 13 | 12/18 | 課程議題(四): 非線性碼<br>(2) Asymmetric errors             |                              |
| 14 | 12/25 | 課程議題(五): ARQ 技術研究                                  |                              |
| 15 | 1/8   | Paper presentation                                 |                              |
| 16 | 1/15  |  |                              |

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## TABLE OF CONTENTS FOR TEXT BOOK

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1. Coding for Reliable Digital Transmission and Storage.
  2. Introduction to Algebra.
  3. Linear Block Codes.
  4. Important Linear Block Codes.
  5. Cyclic Codes.
  6. Binary BCH Codes.
  7. Nonbinary BCH Codes, Reed-Solomon Codes, and Decoding Algorithms.
  8. Majority-Logic Decodable Codes.
  9. Trellises for Linear Block Codes.
  10. Reliability-Based Soft-Decision Decoding Algorithms for Linear Block Codes.
  11. Convolutional Codes.
  12. Trellis-Based Decoding Algorithms for Convolutional Codes.
  13. Sequential and Threshold Decoding of Convolutional Codes.
  14. Trellis-Based Soft-Decision Algorithms for Linear Block Codes.
  15. Concatenated Coding, Code Decomposition and Multistage Decoding.
  16. Turbo Coding.
  17. Low Density Parity Check Codes.
  18. Trellis Coded Modulation.
  19. Block Coded Modulation.
  20. Burst-Error-Correcting Codes.
  21. Automatic-Repeat-Request Strategies.
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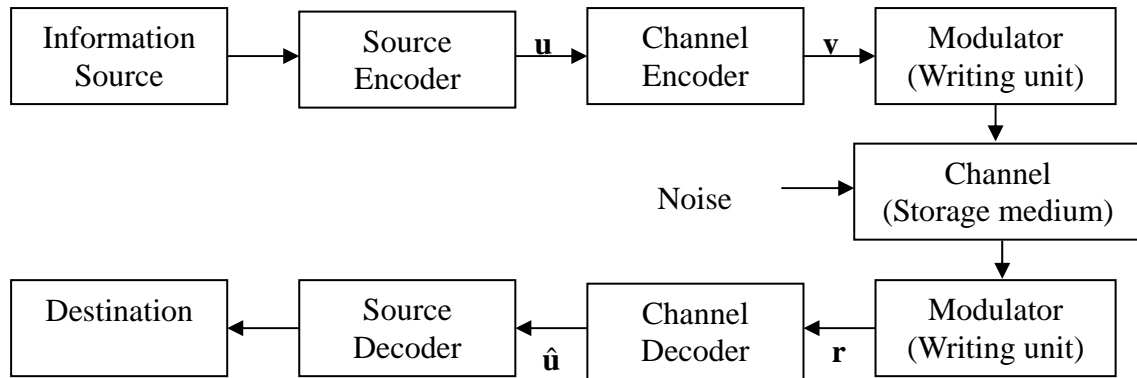


Fig. 1 Block diagram of a typical data transmission storage system

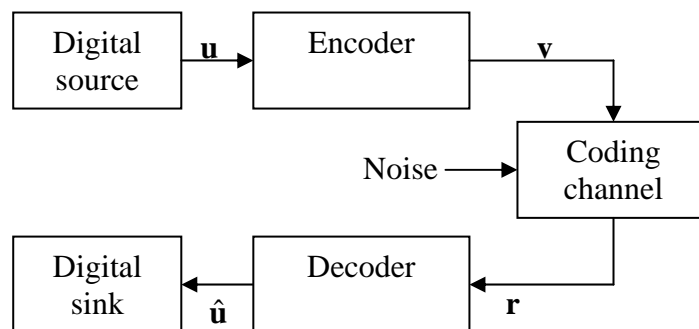


Fig. 2 Simplified model of a coded system

**EXAMPLE: A Binary Linear Block Code ( $n, k$ ) with  $n=7, k=4$**

| $v_i$    | Message ( $u$ ) | Codewords ( $v$ ) |
|----------|-----------------|-------------------|
| $v_1$    | 0000            | <u>0000000</u>    |
| $v_2$    | 1000            | <u>1101000</u>    |
| $v_3$    | 0100            | <u>0110100</u>    |
| $v_4$    | 1100            | <u>1011100</u>    |
| $v_5$    | 0010            | <u>1110010</u>    |
| $v_6$    | 1010            | <u>0011010</u>    |
| $v_7$    | 0110            | <u>1000110</u>    |
| $v_8$    | 1110            | <u>0101110</u>    |
| $v_9$    | 0001            | <u>1010001</u>    |
| $v_{10}$ | 1001            | <u>0111001</u>    |
| $v_{11}$ | 0101            | <u>1100101</u>    |
| $v_{12}$ | 1101            | <u>0001101</u>    |
| $v_{13}$ | 0011            | <u>0100011</u>    |
| $v_{14}$ | 1011            | <u>1001011</u>    |
| $v_{15}$ | 0111            | <u>0010111</u>    |
| $v_{16}$ | 1111            | <u>1111111</u>    |

Some terms and their explanations:

- (1) Hamming Weight: the number of “1”, e.g.,  $W(v_8)=4, W(v_1)=0$ .
- (2) Hamming Distance: the number of different positions between two codewords,  
for example:  $d(v_8, v_9)=7, d(v_5, v_0)=4$ . Note:  $d(v_8, v_9)=W(v_8 \oplus v_9)$
- (3) Minimum weight & Minimum distance.
- (4) Linear.
- (5) Block.