



SWINBURNE
UNIVERSITY OF
TECHNOLOGY

COS10004 Computer Systems

Lecture 5.1 Encoders , Decoders and Multiplexers

CRICOS provider 00111D

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ENCODERS AND DECODERS

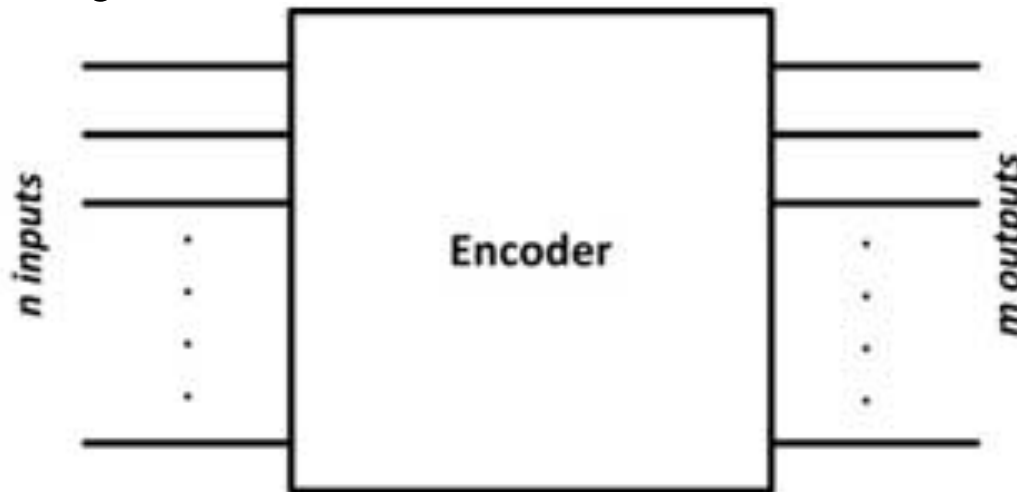
- > Binary signals along a wire can represent a single state, or form part of a binary code
- > Sometimes we want to convert between these representations:
 - We may want to **encode** independent input wires as a single output binary code

OR

- We may want to **decode** a multi-bit binary value to the single output line it represents

ENCODERS

- > Encoders are used to code binary data
 - Converts an active input signal into a coded output signal



- > If an encoder has n Input lines and m output lines then:
 - $n \leq 2^m$

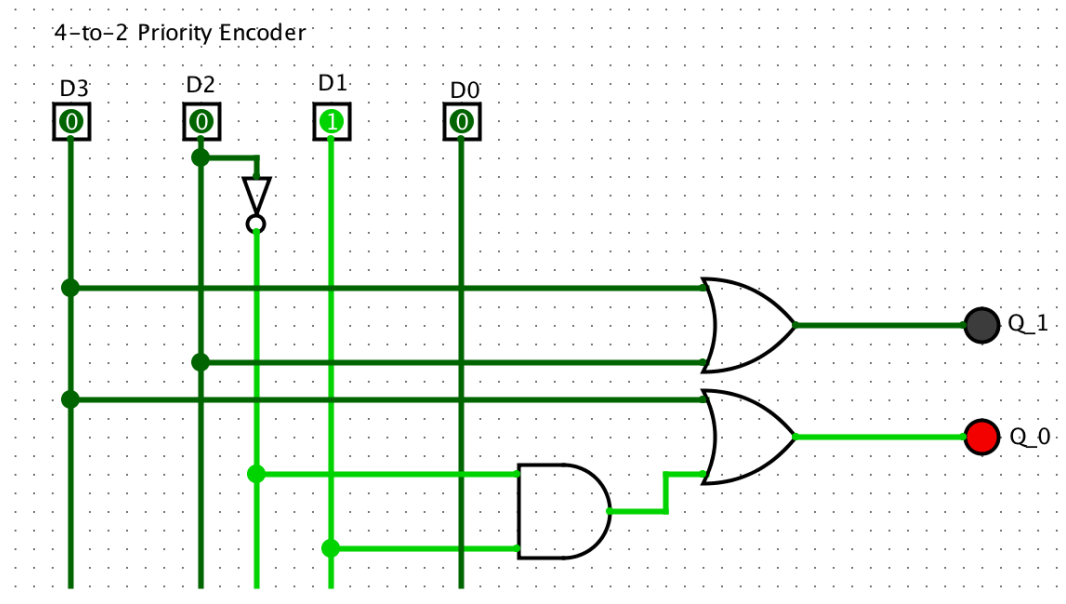
ENCODER EXAMPLE: 4-TO-2 PRIORITY ENCODER

- > Imagine 4 input lines each indicating a priority level
- > We encode the priority as a 2 bit binary number according to the truth table:

Inputs				Outputs	
D ₃	D ₂	D ₁	D ₀	Q ₁	Q ₀
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1
0	0	0	0	x	x

ENCODER EXAMPLE: 4-TO-2 PRIORITY ENCODER

- > Imagine 4 input lines each indicating a priority level
- > We encode the priority as a 2 bit binary number according to the circuit:



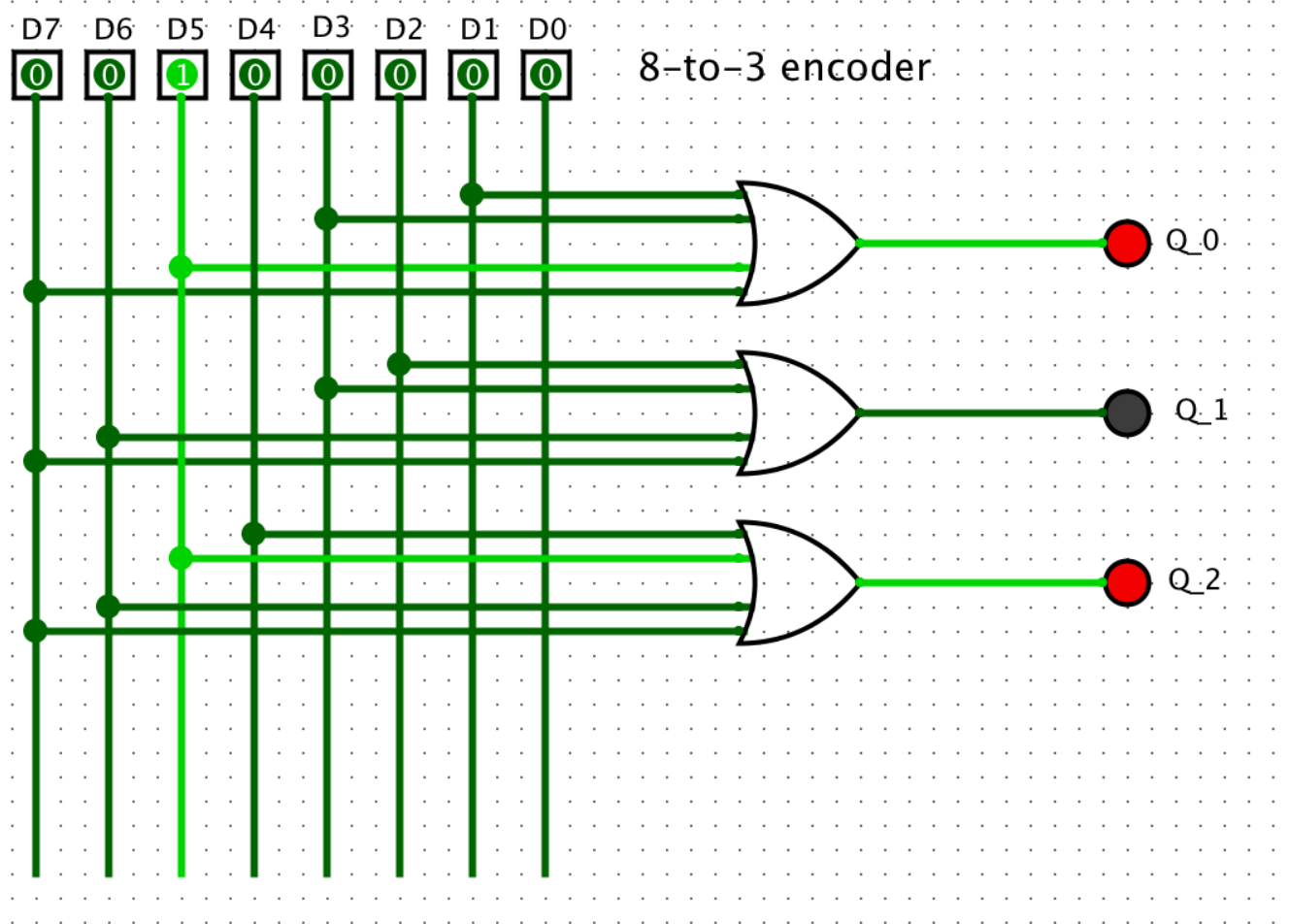
ENCODER EXAMPLE: 4-TO-2 PRIORITY ENCODER

- > Key feature:
 - If multiple inputs are raised High, it will always encode the high priority!
 - Lets try it

ENCODER EXAMPLE: 8-TO-3 PRIORITY ENCODER

- > What about an 8-to-3 encoder ?
- > Try and have a go !
 - Hint: use 3 x 4 input OR gates

ENCODER EXAMPLE: 8-TO-3 PRIORITY ENCODER



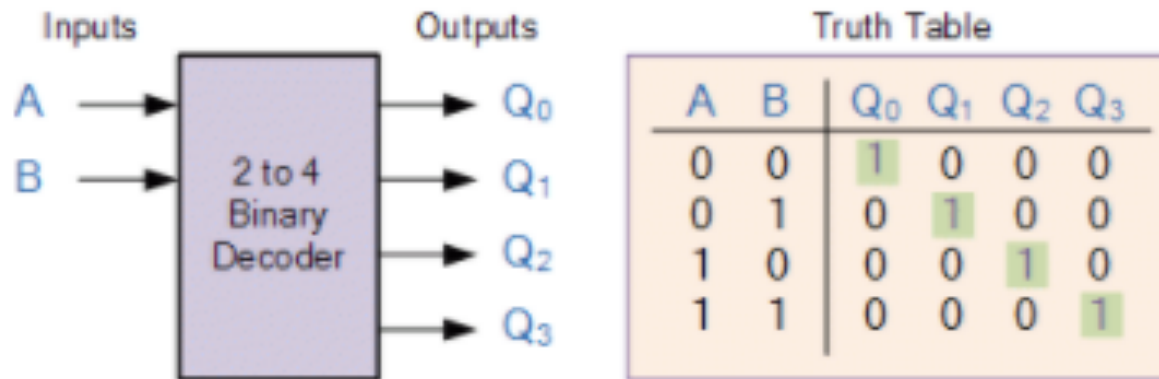
COMMON ENCODER APPLICATIONS

- > Interrupts we talked about last week !
- > Keyboards: Imagine microcomputer reads from keyboard only one button at a time.
 - We can reduce wires by mapping each of the 104 buttons of a QWERTY keyboard into a binary code
 - Eg ASCII code in 7 bits (= output wires)

DECODERS

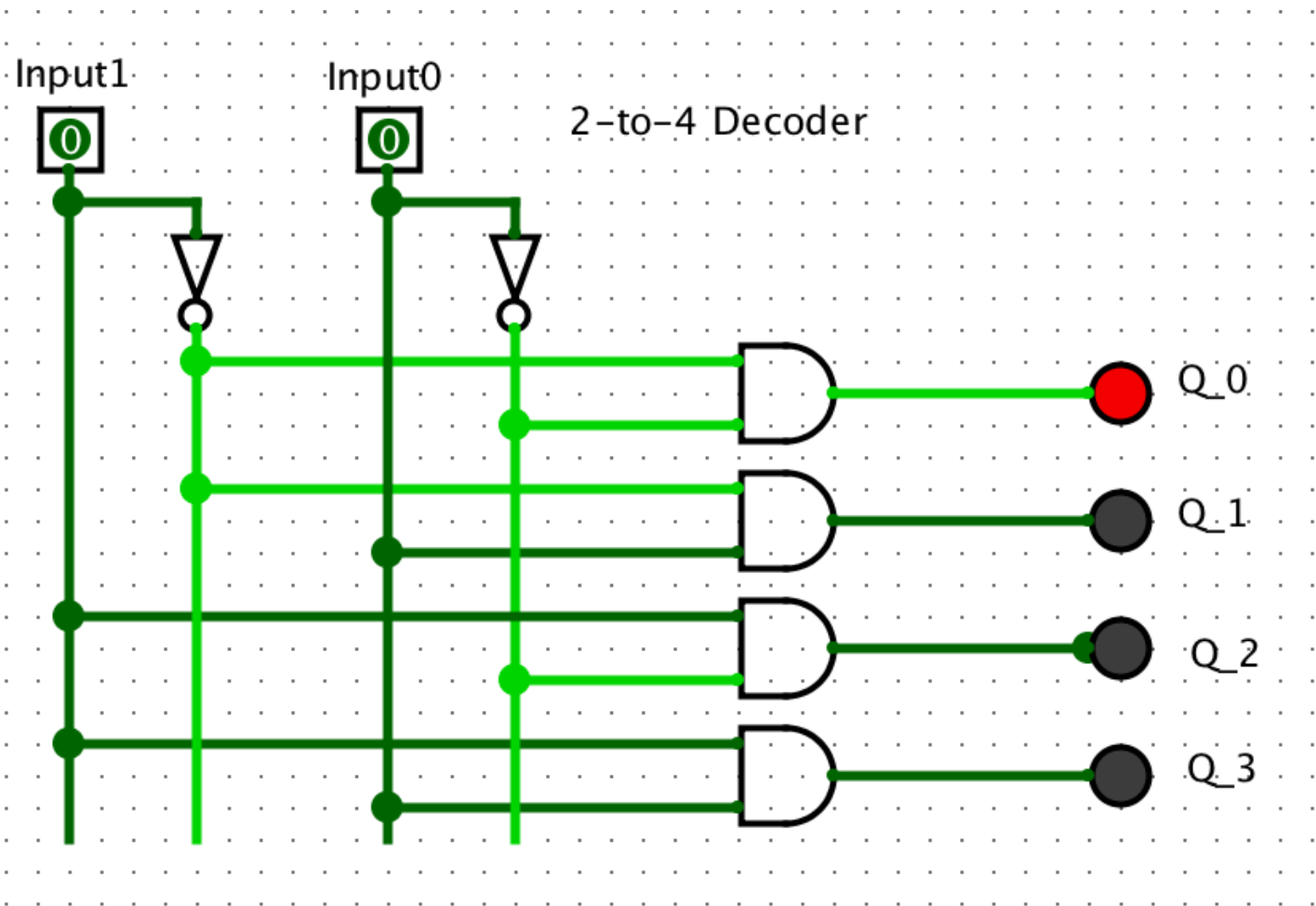
- > Decoders are the opposite of encoders:
 - used to decode binary information
- > Multiple input lines represent a binary code
- > This code is used to select a single output line to raise High
- > If a decoder has n input lines, it can have a maximum 2^n output lines

DECODER EXAMPLE: 2-TO-4 DECODER



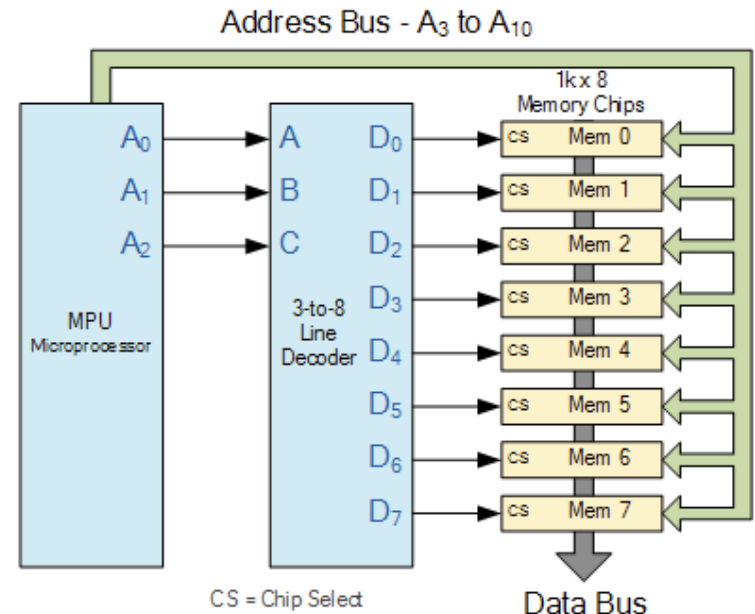
Have a go at designing a circuit to map a 2 bit binary number to select 1 of 4 output lines

DECODER EXAMPLE: 2-TO-4 DECODER



DECODER APPLICATIONS

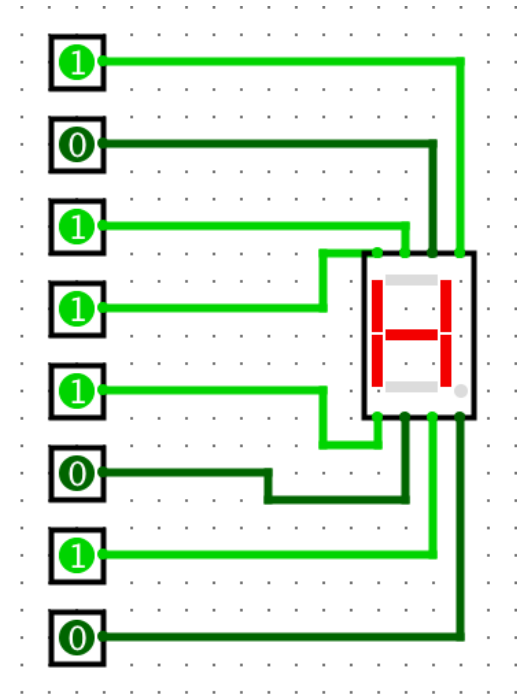
- > Memory Address Decoder
 - Memory commonly stored across multiple chips but transferred over a common bus
 - Each memory chip has a Chip Select (CS) input
 - Memory address is decoded to select the desired chip



Img src: https://www.electronics-tutorials.ws/combinational/comb_5.html

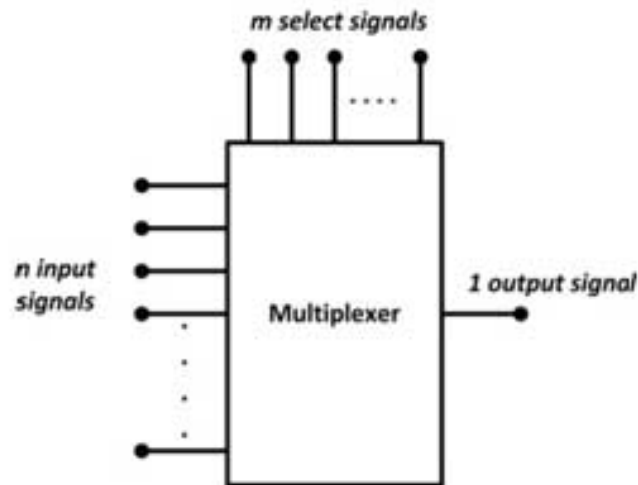
DECODER APPLICATIONS

- > Displays (eg. 7-segment display)
- > 3-8 decoder outputs can feed directly into 7-segment display
- > Similar concept for LCD displays



MULTIPLEXERS

- > Multiplexers (many-to-one) are similar to encoders
- > Used for routing digital data from many to one line.
- > Selects a single input line from several possible lines and sends the data to the output line.

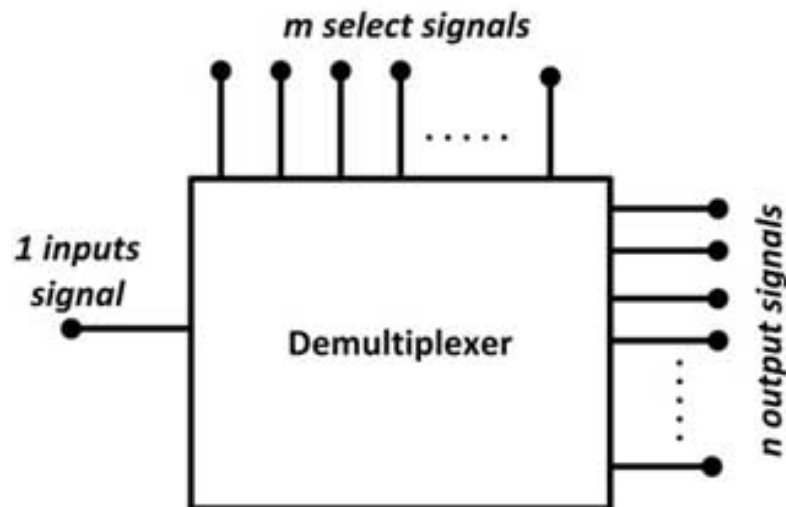


MULTIPLEXER USE-CASES

- > Telephony
- > Communication systems
- > Memory
- > Parallel to serial conversion

DE-MULTIPLEXERS

- > De-Multiplexers (one-to-many) are similar to decoders
- > Used to transmit digital data from one to many lines.
- > Selects an output line from several possible lines and sends the input data to that line.



DE-MULTIPLEXER USE-CASES

- > Communication systems
- > Connecting ALU with registers
- > Serial to parallel conversion

SUMMARY

- > We have covered fundamental combinatorial circuits for data manipulation and transfer
- > Encoders convert an active input signal into a coded output signal
- > Decoders selects a single output line based on a coded output
- > Multiplexers (many-to-one) choose which line to channel data from
- > De-Multiplexers (one-to-many) choose which output line to channel data to