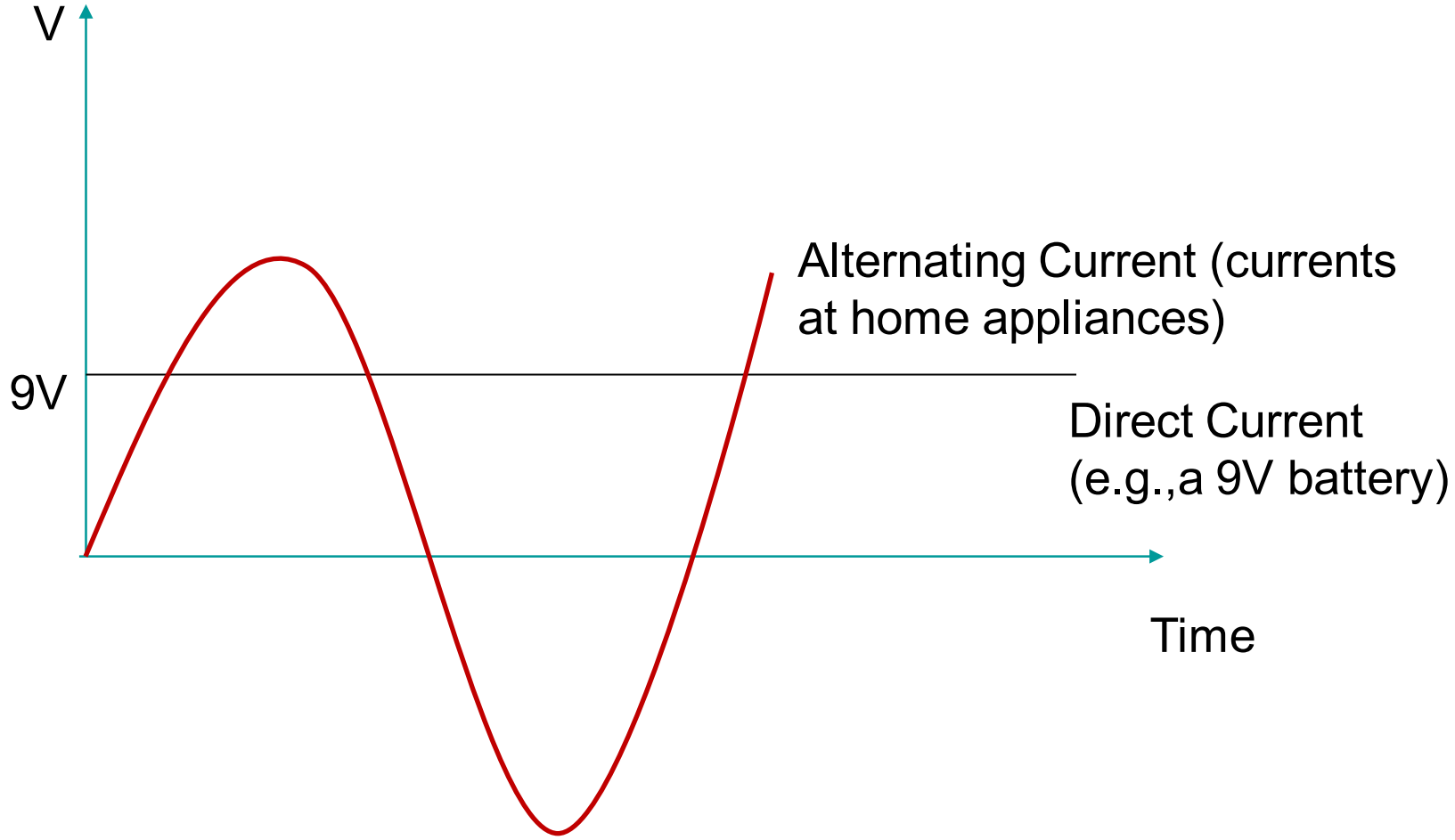
Week 2 – Physical Layer Contd

COMP90007
Internet Technologies

Lets Look at Details: Putting Signals on a Copper Wire



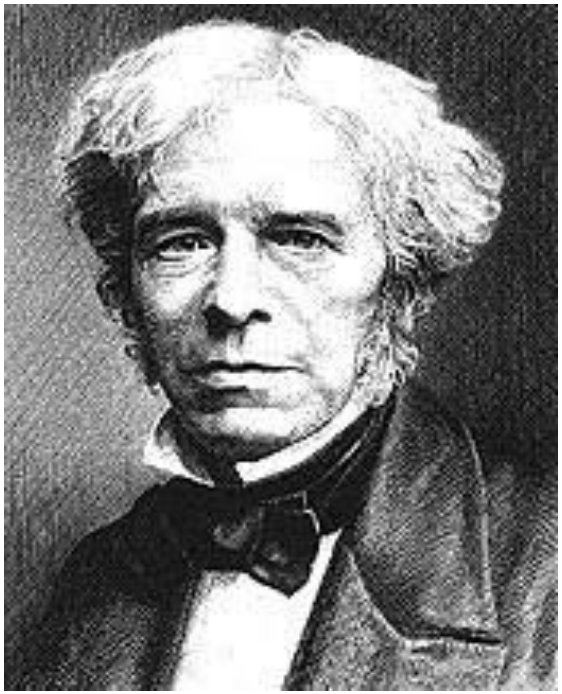
Who found out Electromagnetic Waves Anyway?

- Electromagnetism was first predicted by Maxwell

- Later ***Hertz*** has proved they exist
- His name is used as a unit of frequency now

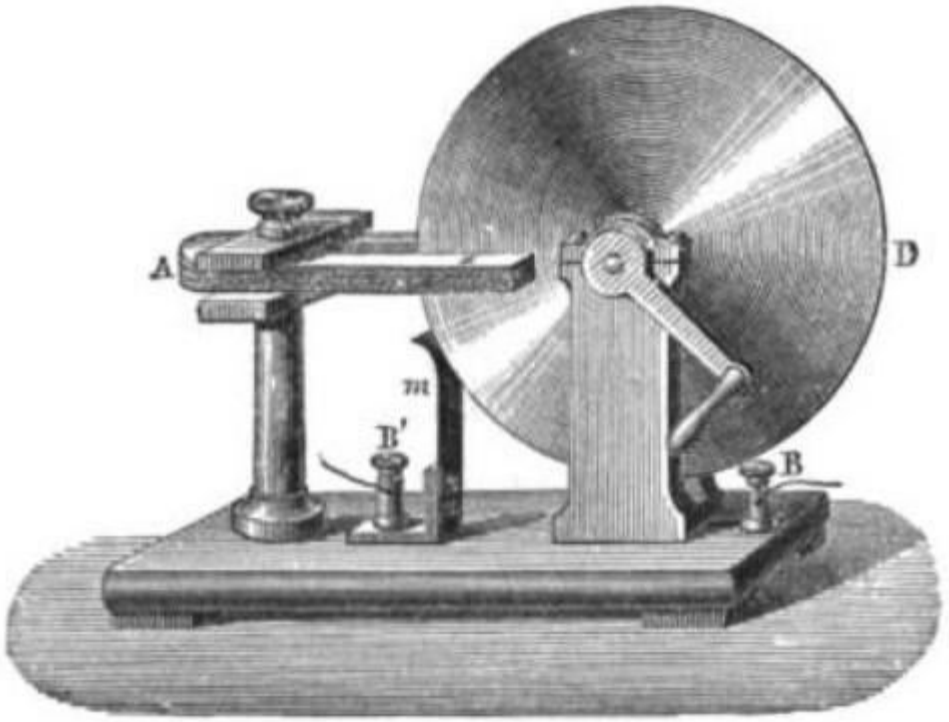
Origins of Electrical Signals

- Electromagnetic induction is at the origins of putting signals on to a wire
- Michael Faraday is the father of this

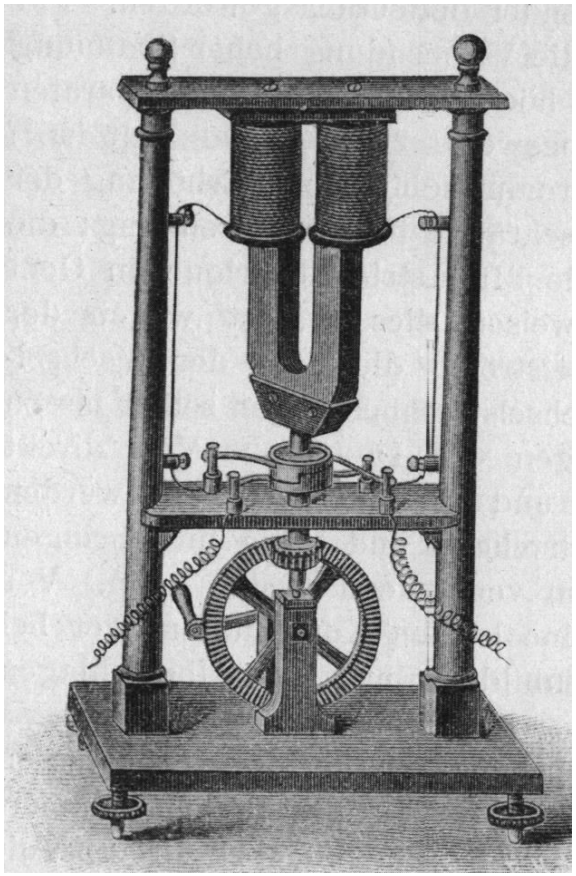


- All these famous scientists lived in 19th century

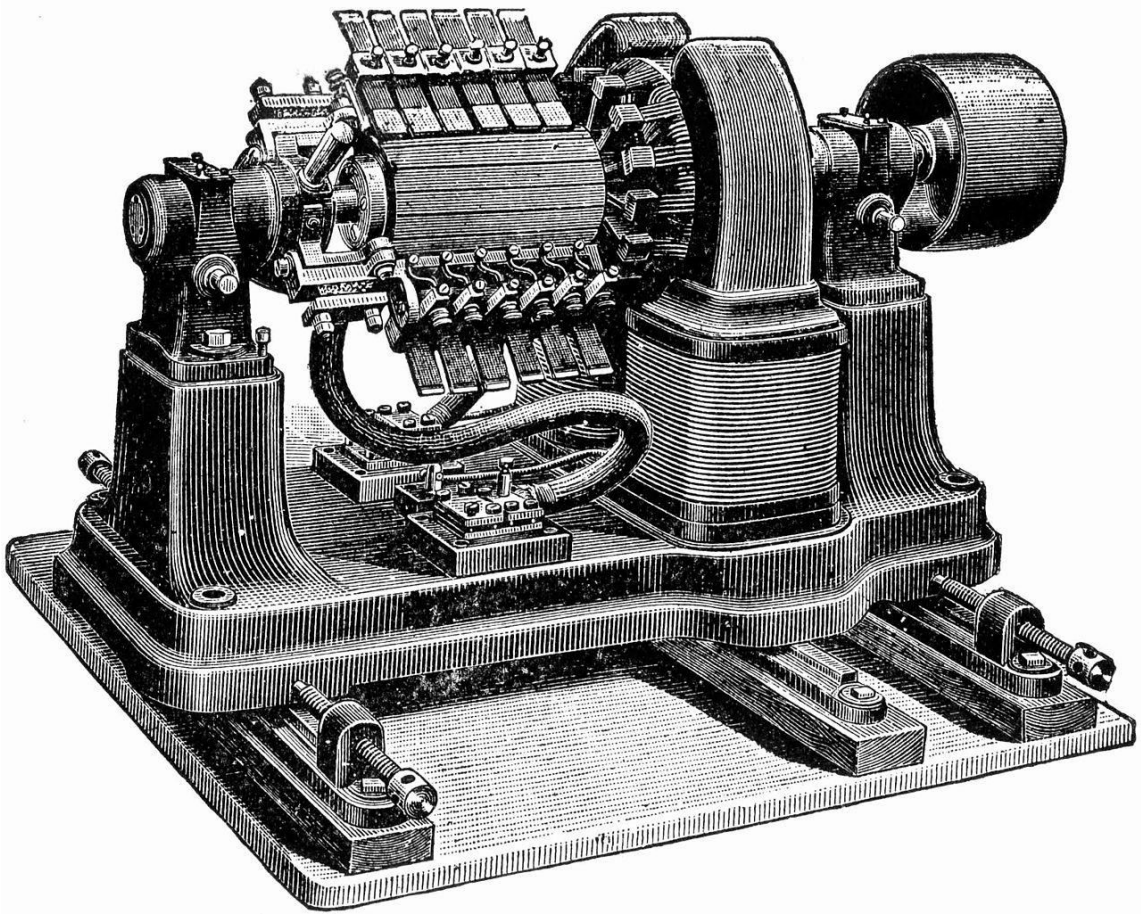
Faraday Disk as An Electric Generator



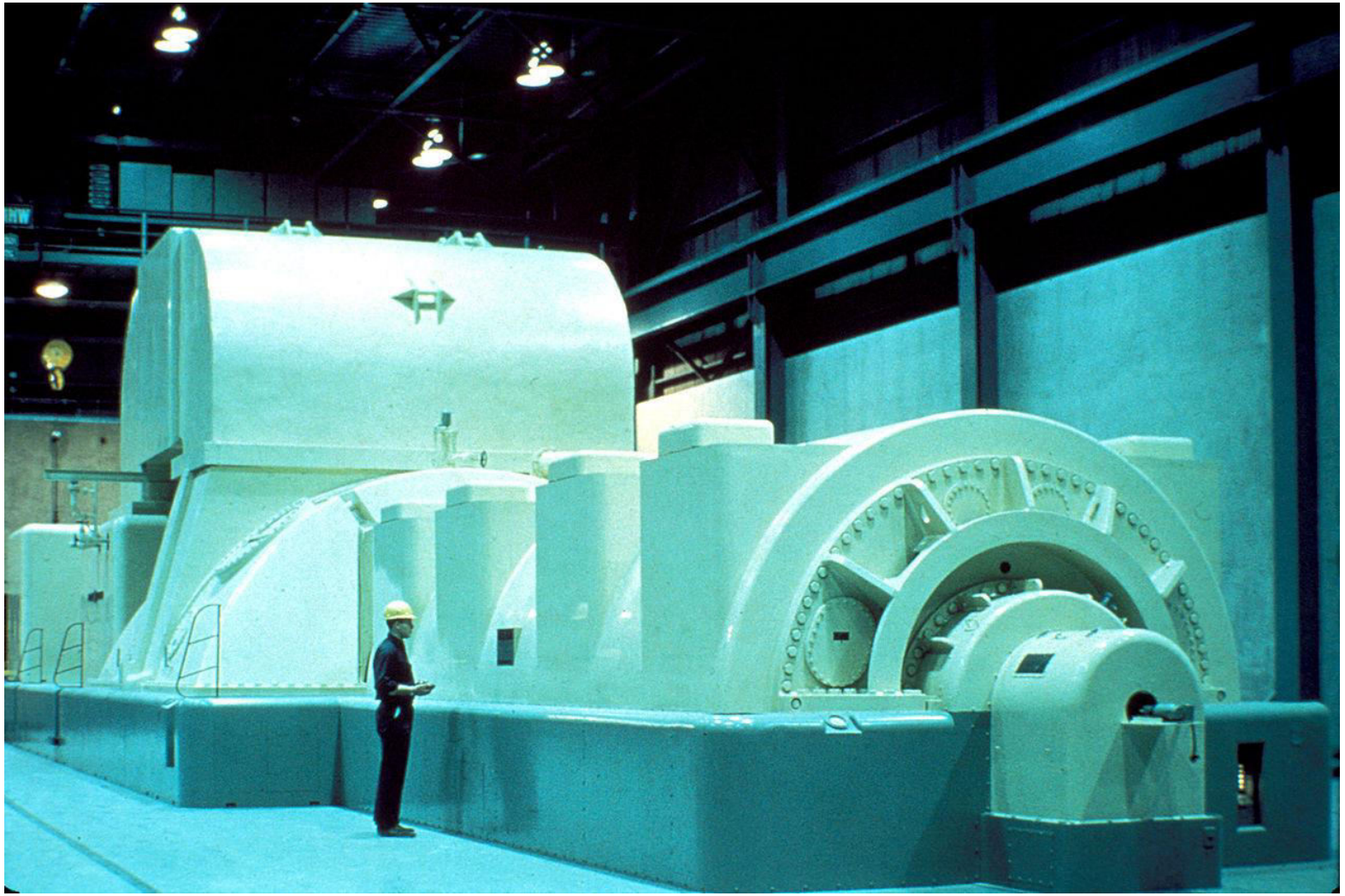
An Early Dynamo



Another Example



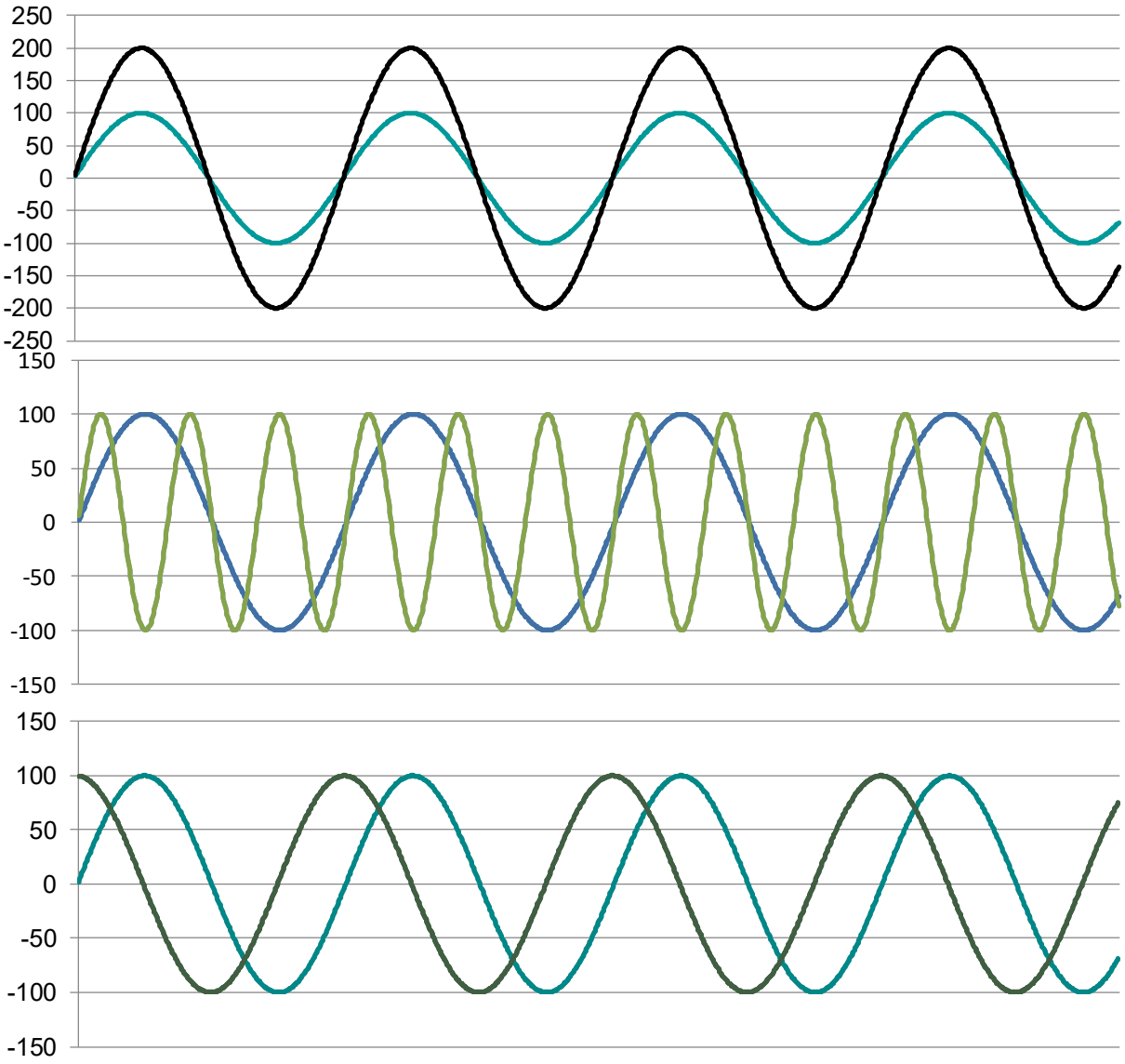
A Turbine



But How Bits Look as a Signal

- Information on wire transmitted by ***varying a physical property*** e.g., voltage, current etc
- Generating a periodic function is needed, imagine a simple Sine function for example
- E.g., the sine function: c*sin(ax+b):
  - Three things can change the behaviour of this function: c: Amplitude, a:Frequency and b:Phase

Change in Amplitude, Frequency, & Phase



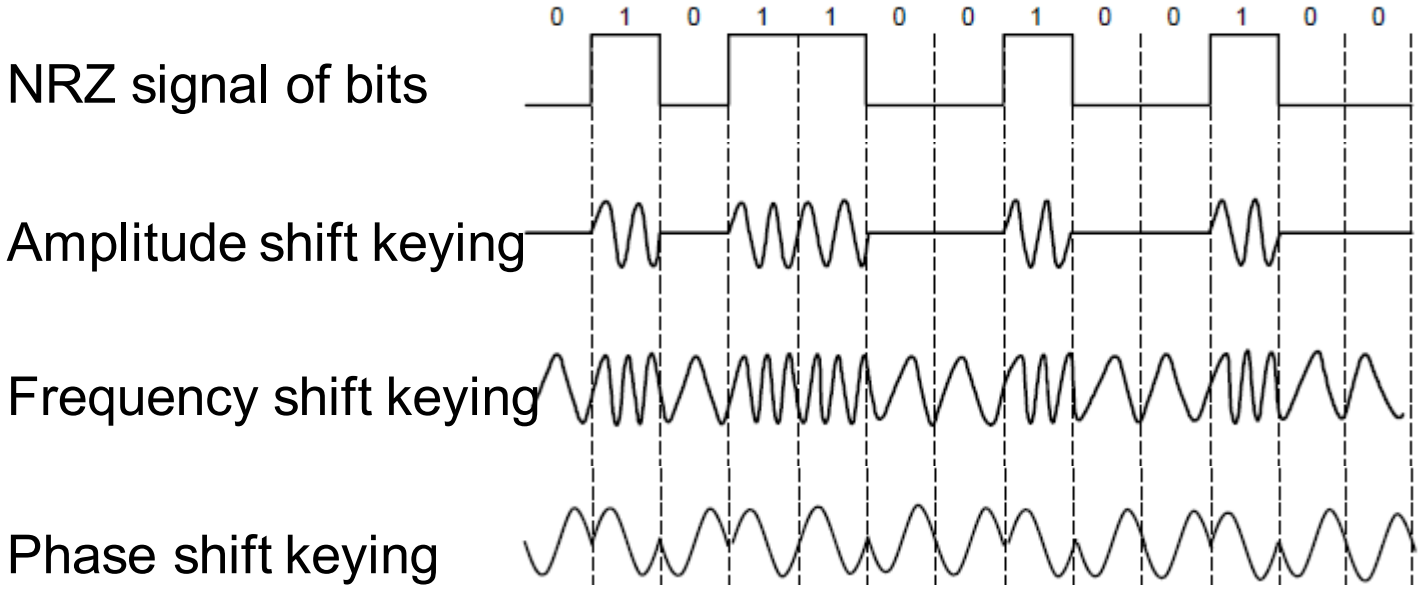
Change in Amplitude

Change in Frequency

Change in Phase

Modulation is the term used

Modulating the amplitude, frequency/phase of a carrier signal sends bits in a (non-zero) frequency range



What Kind of Links We Can Have

Full-duplex link

- Used for transmission in both directions at once
- e.g., use different twisted pairs for each direction

Half-duplex link

- Both directions, but not at the same time
- e.g., senders take turns on a channel

Simplex link

- Only one fixed direction at all times; not common in communications

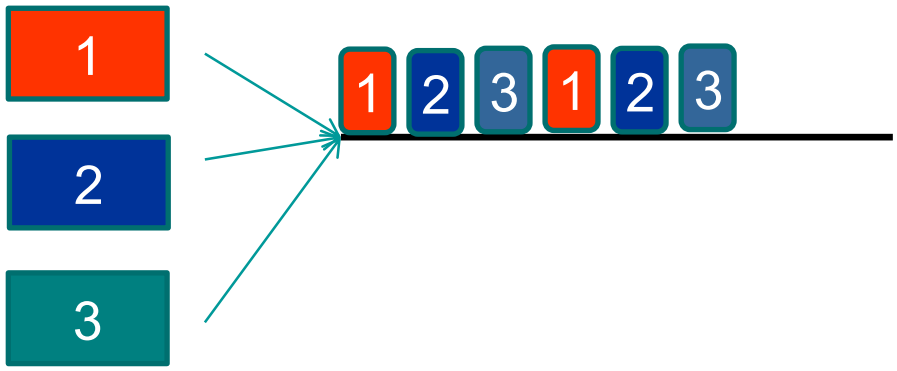
Multiplexing is used for sharing

- When multiple sources want to put things on to a medium
  - Time Division Multiplexing
  - Frequency Division Multiplexing

  - Statistical Multiplexing (for curious readers)
  - Code Division Multiple Access (we will mention later)

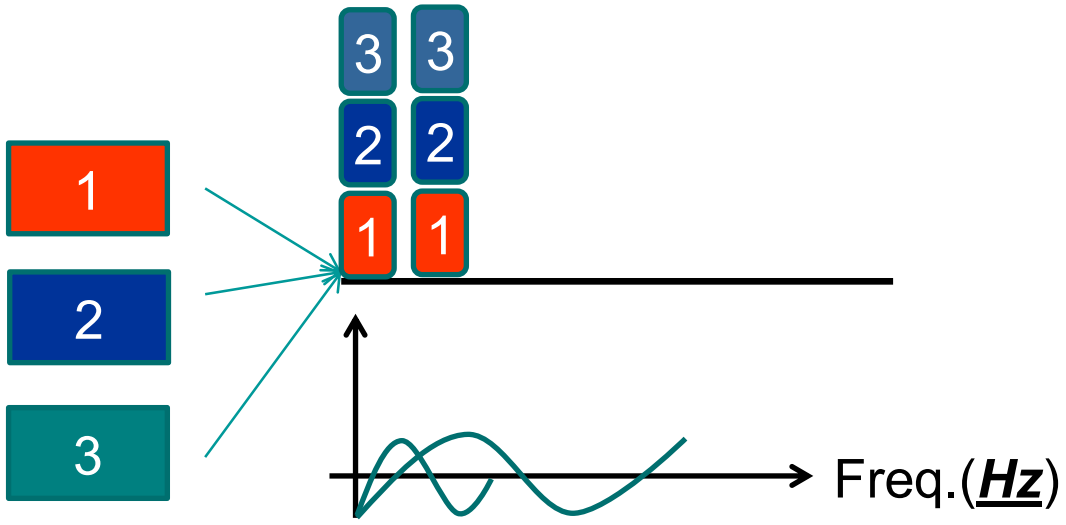
Time Division Multiplexing

- Users can send according to a fixed schedule
- Slotted access to the full speed of the media



Frequency Division Multiplexing

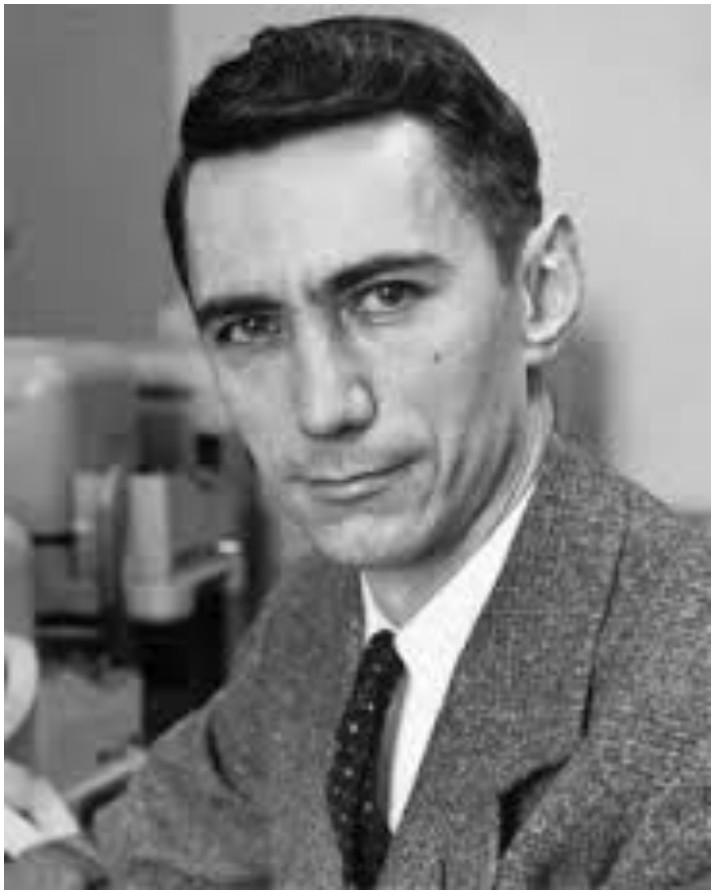
- Users can only use specific frequencies to send their data



How much can we put on a link?

- Harry Nyquist: Early theoretical work on determining fundamental limits for the bandwidth required for communication which heralded the digital revolution
- Nyquist's theorem ***relates the data rate in bits per second to the bandwidth given in Hertz***

Claude Shannon: Adds Noise Considerations



- Father of Information theory as well as many things in Cryptography
- Shannon's theorem ***relates the data rate to the bandwidth by using signal strength where there is noise***
- Together they give a limit on how much you can send on a medium in Bits per Second, hence our bandwidth…