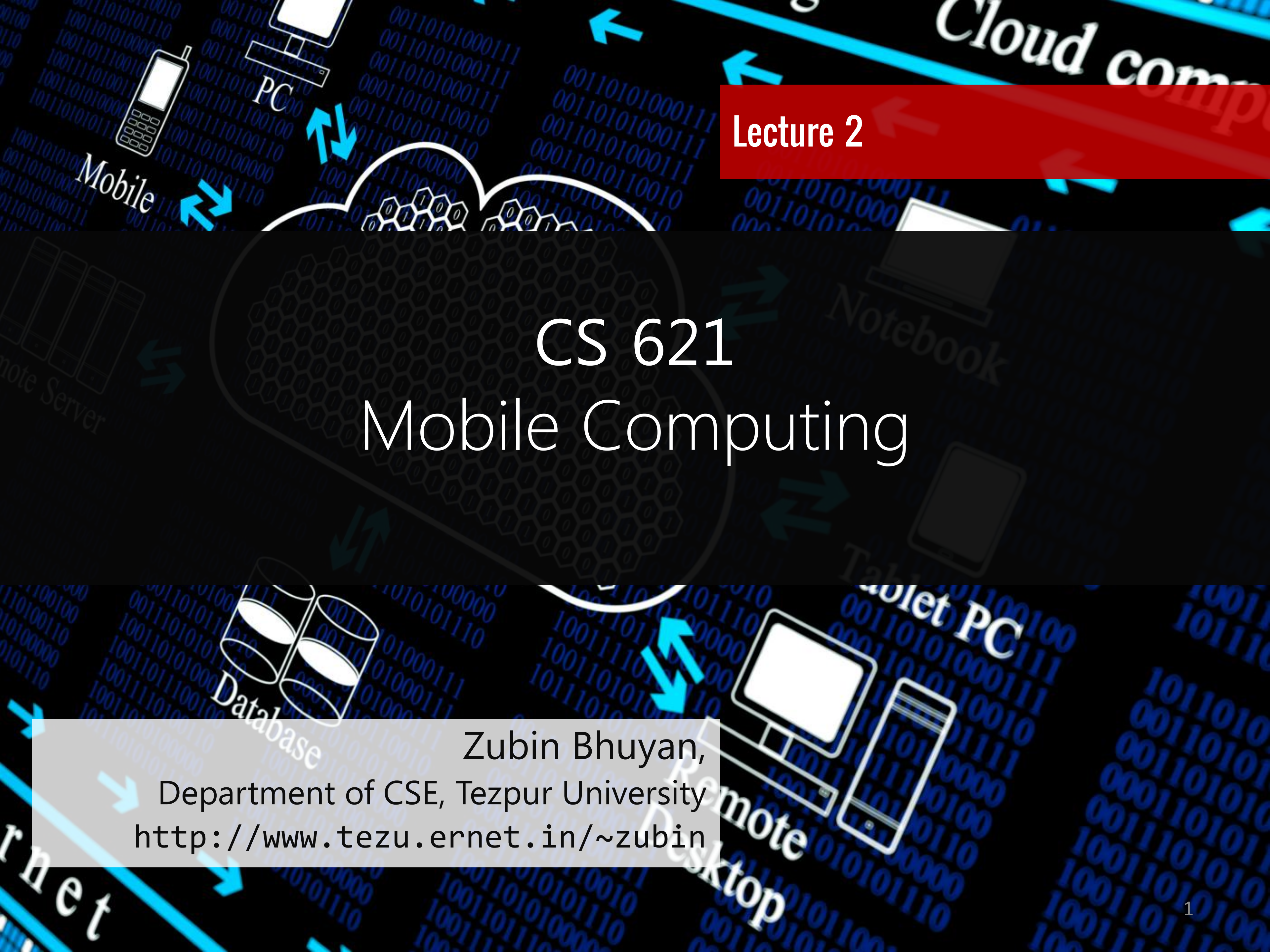

Lecture 2

CS 621
Mobile Computing

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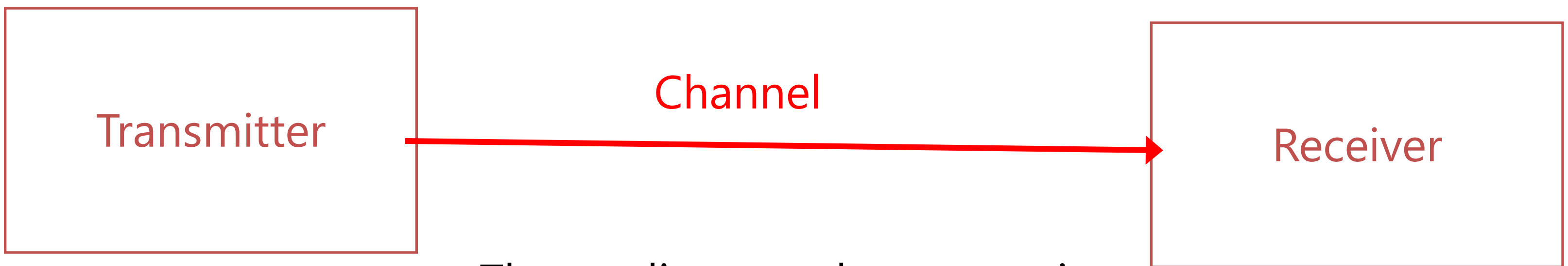
Communication Channel



The medium used to transmit the signal from the transmitter to the receiver

Wireline / Wireless channel

Bit Error Rate

- Optical fiber: 10^{-11} or 10^{-12}
- Mobile channel:
  - Good quality: 10^{-6}
  - Actual condition: 10^{-2} or worse

Thus,

- For wireline systems, it is assumed that the channel is error free
- Many protocols are designed with this assumption
- These protocols do not work well in a wireless environment
  - e.g. TCP (*Packet loss is only due to congestion, not due to error in channel*)

Multiple Transmitters

- For wireline systems, we can simply install new cables to increase capacity.

- For wireless systems, the channel can only be shared by the users.
  - Capacity does not increase.

Interference

- **Interference** is a phenomenon in which two waves superpose to form a resultant wave of greater or lower amplitude.

- In communications and electronics, interference is anything which modifies, or disrupts a signal as it travels along a channel between a source and a receiver.[Wikipedia]

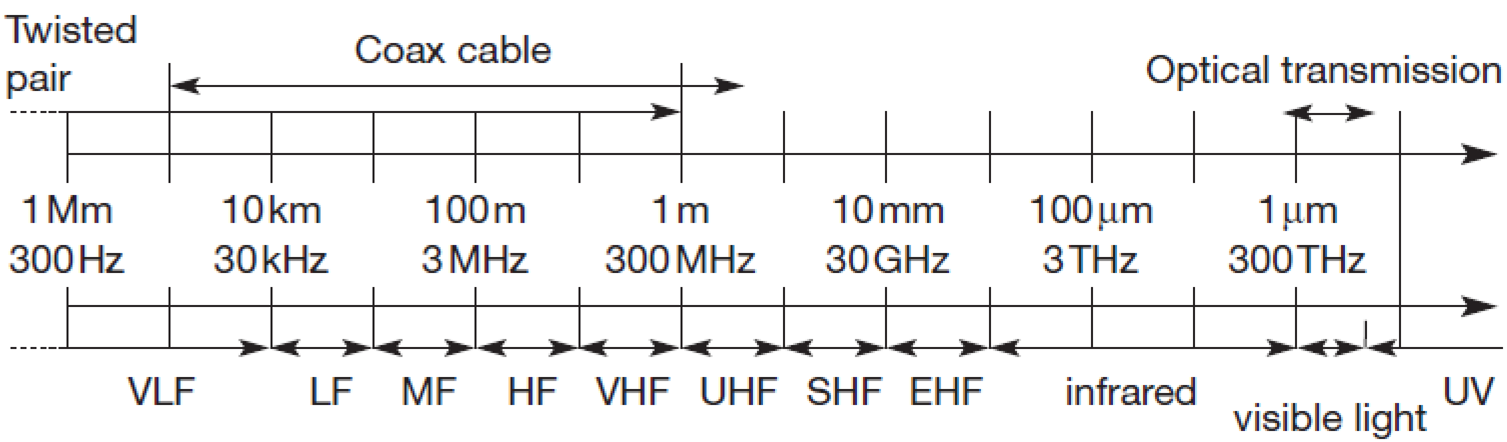
Interference

- While transmission over different wires typically does not USUALLY cause interference, this is an important issue in wireless transmission.

- Multiuser Interference
  - Radio signals of different users interfere with each other
- Self-Interference
  - Multipath effect
  - Phase-shifted images of the signal at the receiver interact and may cancel the entire signal, (i.e. destructive interference).

Radio Transmission Frequencies

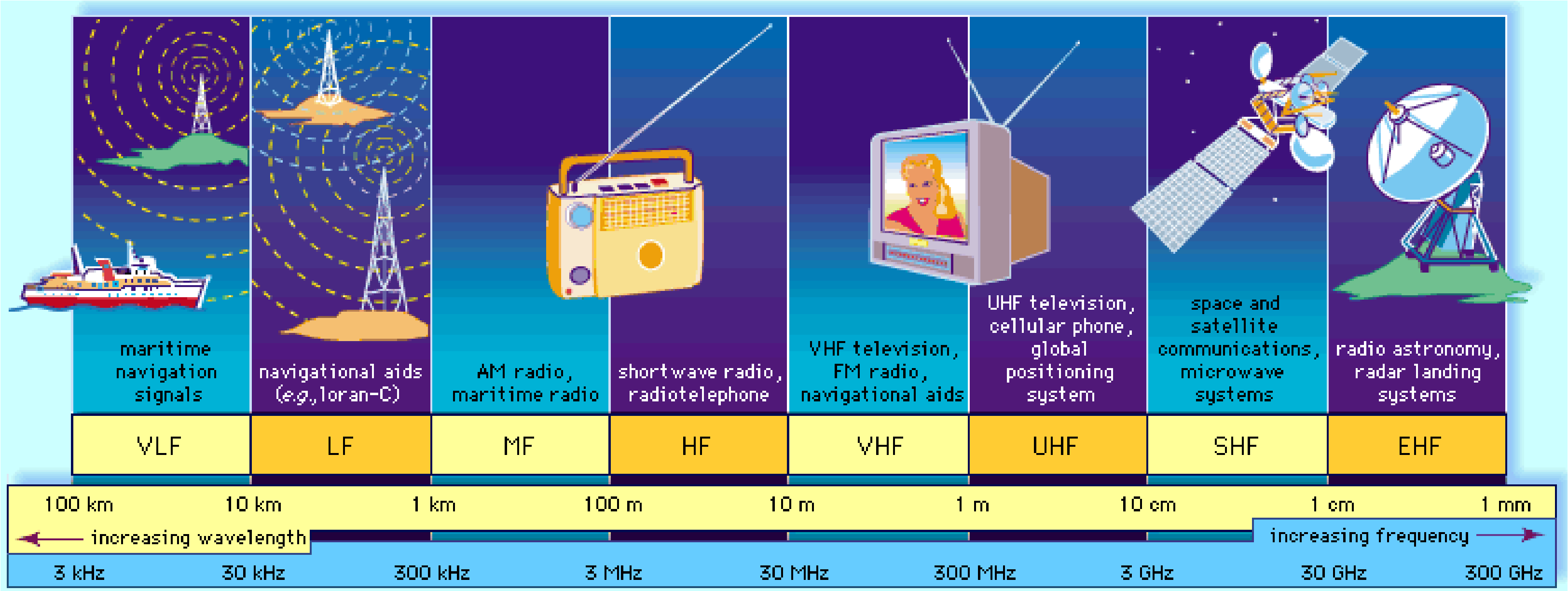
- Radio transmission can take place using many different frequency bands.



- Reminder note: $\lambda = c/f$, *where f is the frequency and* $c = 3 \times 10^{8}$ *ms-2*

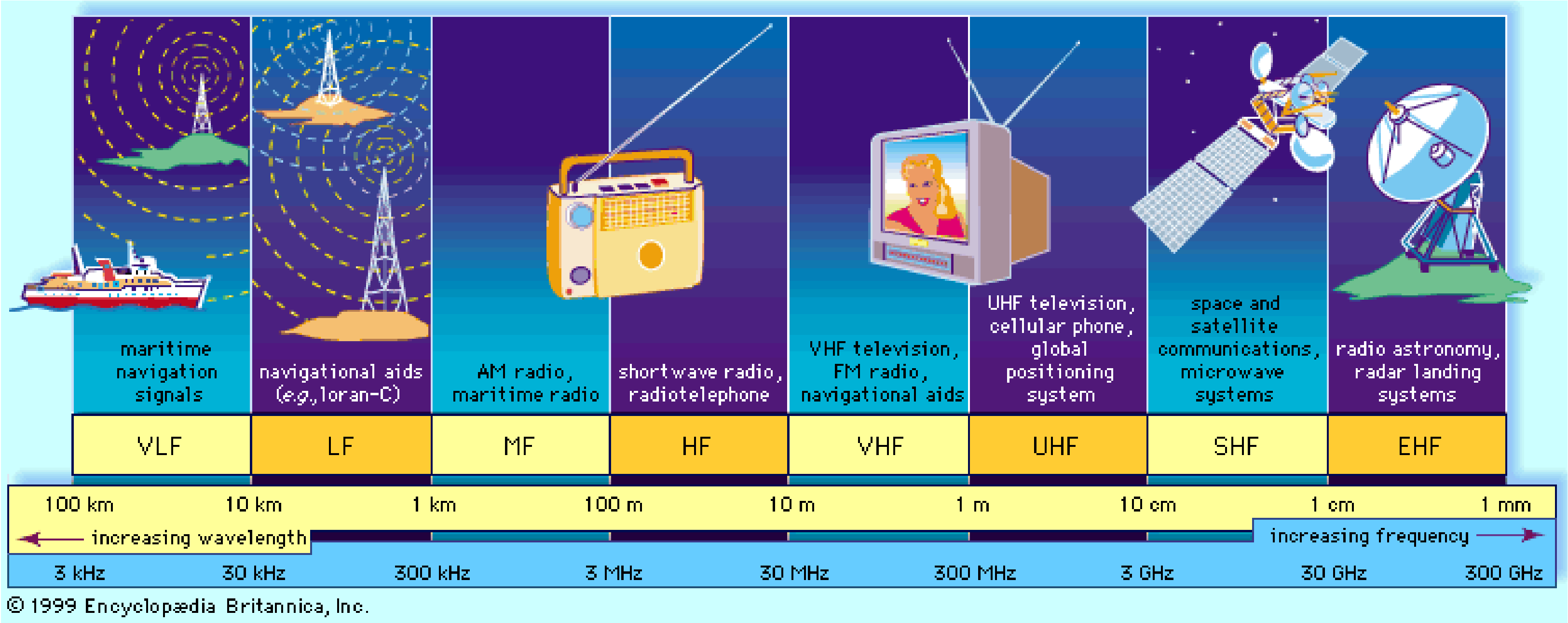
Radio Transmission Frequencies

- Radio transmission starts at several kHz, the very low frequency (VLF) range.
- The medium frequency (MF) and high frequency (HF) ranges are typical for transmission of hundreds of radio stations.



Radio Transmission Frequencies

- Conventional analog TV is transmitted in ranges of 174–230 MHz and 470–790 MHz using the very high frequency (VHF) and ultra high frequency (UHF) bands.
- GSM falls in 890–960 MHz, 1710–1880 MHz.



Signals

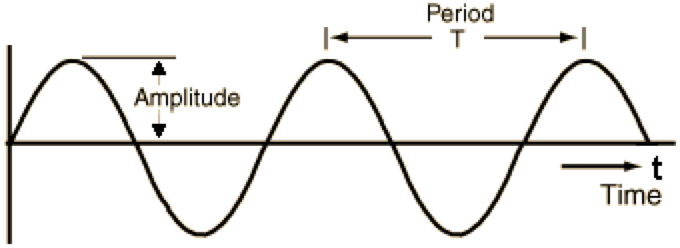
- Signals are the physical representation of data.
- The Physical Layer of the ISO/OSI basic reference model is responsible for the conversion of data, i.e., bits, into signals and vice versa.
- General function of sine wave is:

$$g(t) = A_t \sin(2\pi f_t t + \varphi_t)$$

The Sine Wave

$$g(t) = A_t \sin(2\pi f_t t + \varphi_t)$$

- Signals parameters are:
  - Amplitude *A*
  - Frequency *f*
  - Phase shift *φ*

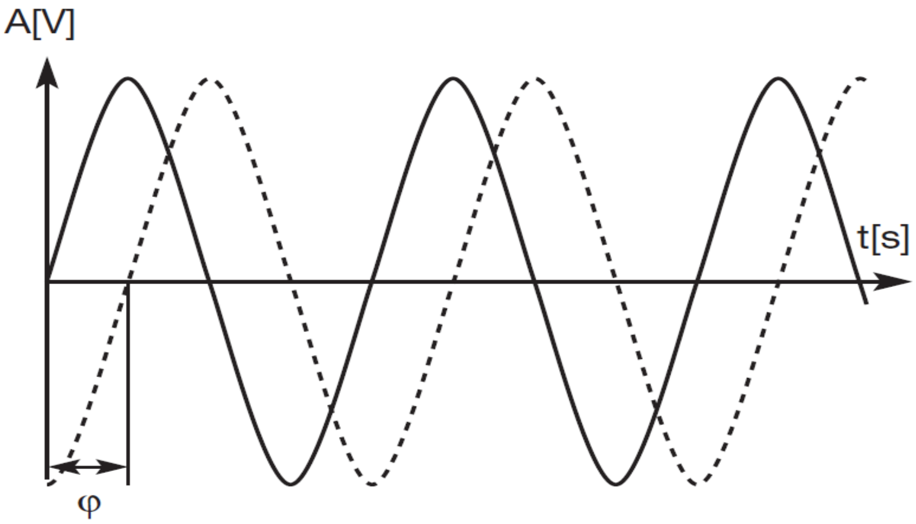


- Frequency *f* expresses the periodicity of the signal with T = 1/*f*.
- The phase shift determines the shift of the signal relative to the same signal without a shift.
- The amplitude A_t of a function *g* may also change with time.

The Sine Wave

$$g(t) = A_t \sin(2\pi f_t t + \varphi_t)$$

- The phase shift determines the shift of the signal relative to the same signal without a shift.



- a sine function without a phase shift and the same function, i.e., same amplitude and frequency, with a phase shift

Signals

- It is possible to construct every periodic signal *g* by using *only sine* and cosine functions.

$$g(t) = \frac{1}{2}c + \sum_{n=1}^{\infty} a_n \sin(2\pi nft) + \sum_{n=1}^{\infty} b_n \cos(2\pi nft)$$

- *c determines the* ***DC component*** of the signal
- a_n *and* b_n *are the amplitudes of the* n^{th} *sine and cosine functions.*

- [Recap: Fourier Transform]

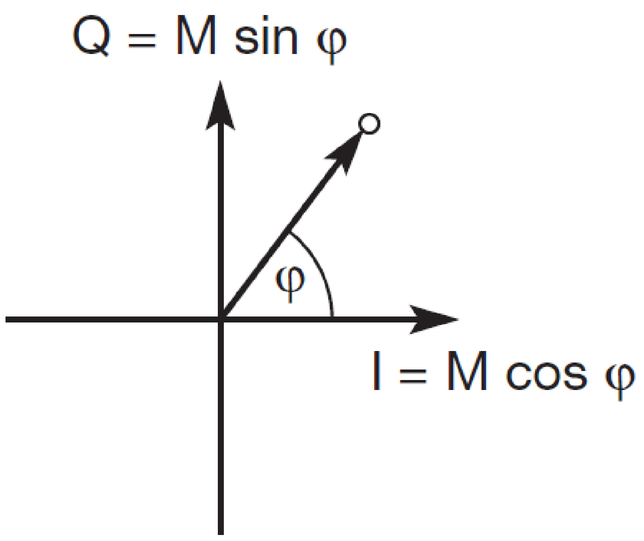
Frequency Domain representation

- The amplitude of a certain frequency part of the signal is shown versus the frequency.

- *Frequency spectrum of a signal*

Phase Domain representation

- The amplitude M of a signal and its phase *φ in polar* coordinates.
  - length of the vector represents the amplitude
  - the angle the phase shift



- The x-axis represents a phase of 0 aka, In-phase(I).
- phase shift of 90° or *π/2 would be a point on the y-axis, called* ***Quadrature.***

THANKS!