UNIVERSITAS KOMPUTER INDONESIA

Bab 7. Modulasi

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UNIVERSITAS KOMPUTER INDONESIA

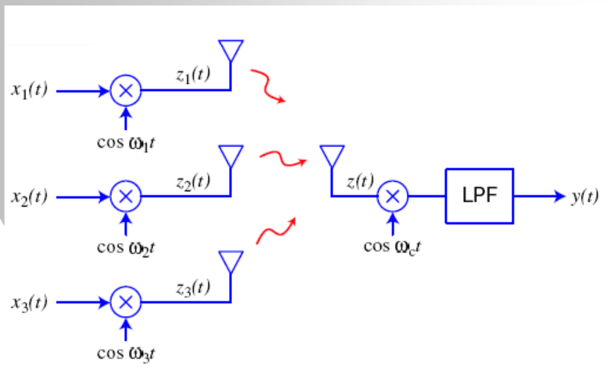
Sistem Komunikasi

- Sinyal tidak selalu matching dengan media pengirim

Sinyal	Aplikasi
Audio	telepon, radio, phonograph, CD, Ponsel, MP3
Video	Televisi, sinema, HDTV, DVD
Internet	Coaxial, Twisted pair, cable TV, ADSL, Optical Fiber, E/M

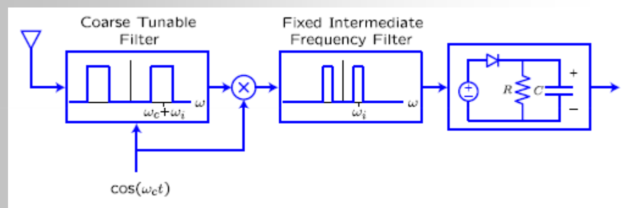
Amplitude Modulation

- Amplitude Modulation dapat digunakan untuk menyelaraskan (match) frekuensi audio dengan frekuensi radio.
- AM juga dapat digunakan untuk transmisi paralel dari multi channel



Superheterodyne Receiver

- Edwin Howard Armstrong menemukan penerima superheterodyne , yang membuat broadcast AM lebih praktis



- Edwin Howard Armstrong juga menemukan paten untuk rangkaian regeneratif (positive feedback) yang mengamplifikasi sinyal radio (saat ia masih junior di Univeritas Columbia)
  Ia juga menemukan wideband FM

Amplitude, Phase, and Frequency Modulation

- Cara-cara memasukan pesan pada gelombang pembawa (carrier), Tiga diantaranya

Amplitude Modulation (AM):	$y_1(t) = x(t)\cos(\omega_c t)$
Phase Modulation (PM):	$y_2(t) = \cos(\omega_c t + kx(t))$
Frequency Modulation (FM):	$y_3(t) = \cos\left(\omega_c t + k\int_{-\infty}^{t} x(\tau)d\tau\right)$

Frequency Modulation

- Pada FM, sinyal memodulasi frekuensi sinyal pembawa sesaat

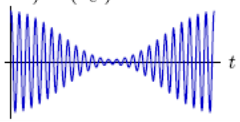
$$y_3(t) = \cos\left(\omega_c t + \underbrace{k\int_{-\infty}^{t} x(\tau)d\tau}_{\phi(t)}\right)$$

$$\omega_i(t) = \omega_c + \frac{d}{dt}\phi(t) = \omega_c + kx(t)$$

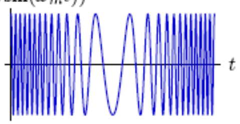
Frequency Modulation

- Bandingkan AM dan FM

AM: $y_1(t) = (\cos(\omega_m t) + 1.1)\cos(\omega_c t)$



FM: $y_3(t) = \cos(\omega_c t + m\sin(\omega_m t))$



- Keuntungan FM:
  - Daya konstan
  - Tidak perlu mentransmitkan gelombang pembawa (kecuali DC)
  - Bandwidth?

Frequency Modulation

- Peneliti dahulu berpikir narrowband FM dapat memiliki narrow band sembarang, membuat lebih banyak channel dari AM. Tapi salah

$$y_3(t) = \cos\left(\omega_c t + k\int_{-\infty}^{t} x(\tau)d\tau\right)$$

$$= \cos(\omega_c t) \times \cos\left(k\int_{-\infty}^{t} x(\tau)d\tau\right) - \sin(\omega_c t) \times \sin\left(k\int_{-\infty}^{t} x(\tau)d\tau\right)$$

If $k \to 0$ then

$$\cos\left(k\int_{-\infty}^{t} x(\tau)d\tau\right) \to 1$$

$$\sin\left(k\int_{-\infty}^{t} x(\tau)d\tau\right) \to k\int_{-\infty}^{t} x(\tau)d\tau$$

$$y_3(t) \approx \cos(\omega_c t) - \sin(\omega_c t) \times \left(k\int_{-\infty}^{t} x(\tau)d\tau\right)$$

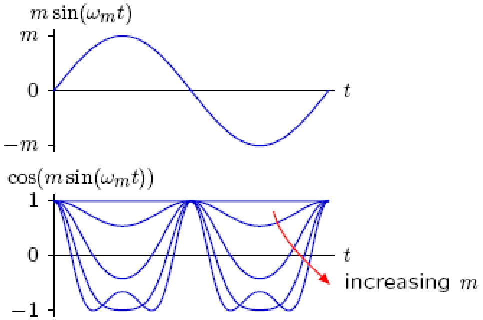
- Bandwidth dari Narrowband FM sama dengan AM. (Pengintegralan tidak mengubah bandwidth)

Phase/Frequency Modulation

- CarilahTransformasi dari Sinyal PM

$$x(t) = \sin(\omega_m t)$$
$$y(t) = \cos(\omega_c t + m x(t)) = \cos(\omega_c t + m \sin(\omega_m t))$$
$$= \cos(\omega_c t)\cos(m \sin(\omega_m t)) - \sin(\omega_c t)\sin(m \sin(\omega_m t))$$

$x(t)$ is periodic in $T = \frac{2\pi}{\omega_m}$, therefore $\cos(m \sin(\omega_m t))$ is periodic in T.



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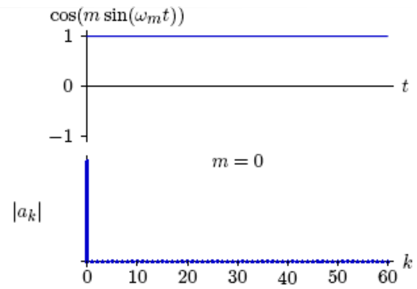

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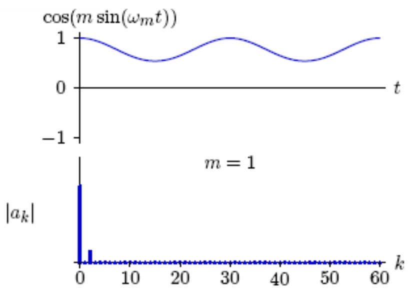

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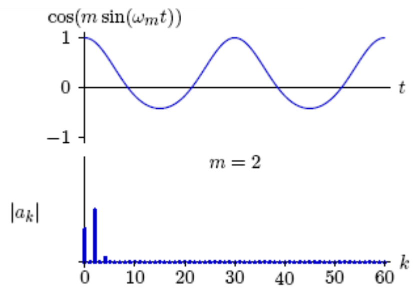

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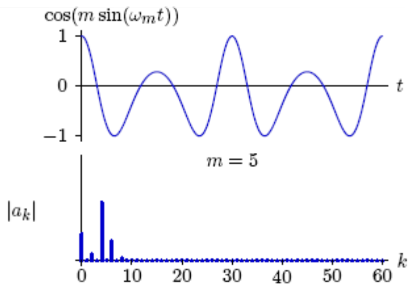

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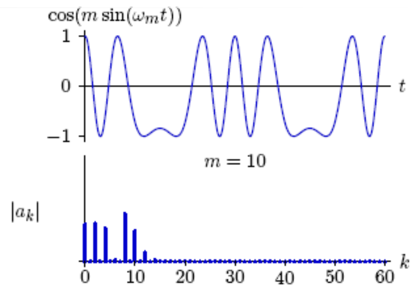

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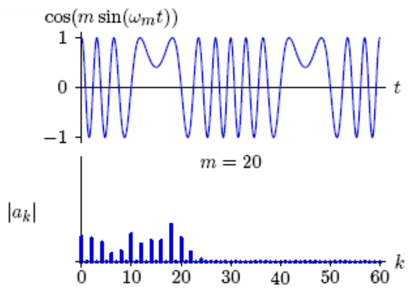

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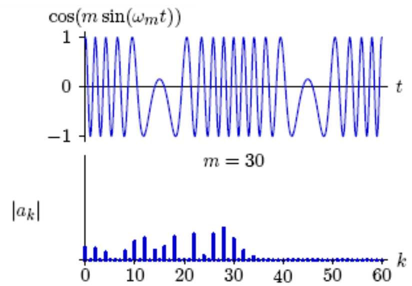

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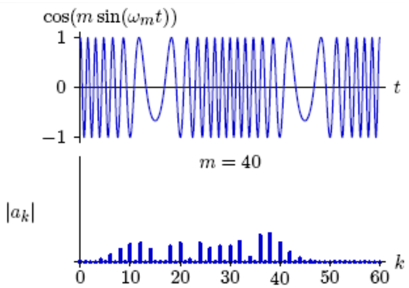

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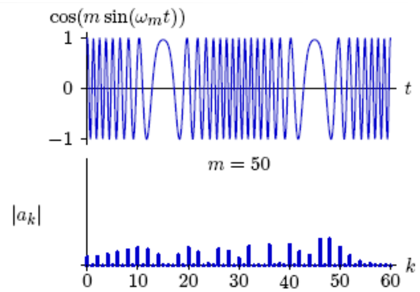
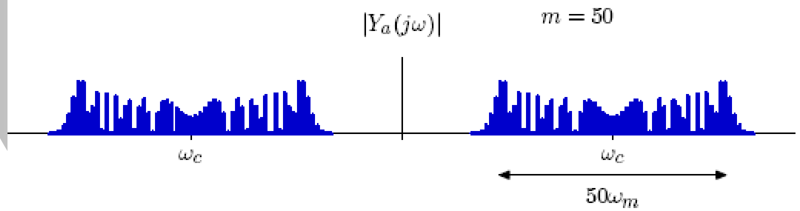


Phase/Frequency Modulation

- Transformasi Fourier dari bag. pertama

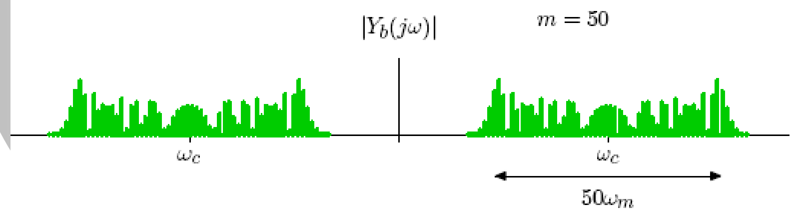
$$x(t) = \sin(\omega_m t)$$
$$y(t) = \cos(\omega_c t + m x(t)) = \cos(\omega_c t + m \sin(\omega_m t))$$
$$= \underbrace{\cos(\omega_c t)\cos(m \sin(\omega_m t))}_{y_a(t)} - \sin(\omega_c t)\sin(m \sin(\omega_m t))$$



Phase/Frequency Modulation

- Transformasi Fourier dari bag. kedua

$$x(t) = \sin(\omega_m t)$$
$$y(t) = \cos(\omega_c t + m x(t)) = \cos(\omega_c t + m \sin(\omega_m t))$$
$$= \cos(\omega_c t)\cos(m \sin(\omega_m t)) - \underbrace{\sin(\omega_c t)\sin(m \sin(\omega_m t))}_{y_b(t)}$$



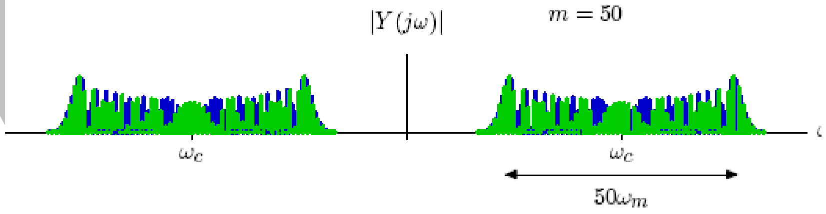
Phase/Frequency Modulation

- Transformasi Fourier

$$x(t) = \sin(\omega_m t)$$

$$y(t) = \cos(\omega_c t + m x(t)) = \cos(\omega_c t + m \sin(\omega_m t))$$

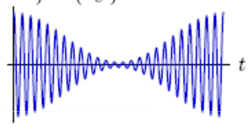
$$= \underbrace{\cos(\omega_c t)\cos(m \sin(\omega_m t))}_{y_a(t)} - \underbrace{\sin(\omega_c t)\sin(m \sin(\omega_m t))}_{y_b(t)}$$



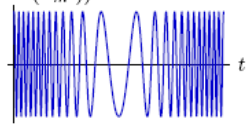
Frequency Modulation

- Wideband FM sangat berguna karena tegar (robust) terhadap noise

AM: $y_1(t) = (\cos(\omega_m t) + 1.1)\cos(\omega_c t)$



FM: $y_3(t) = \cos(\omega_c t + m \sin(\omega_m t))$



- FM membangkitkan sinyal yg sangat redudan (berulang), yang mengurangi keberadaan noise