APECE-302: Radio & Television Engineering

Applied Physics, Electronics & Communication Engineering

Lecture # 09

University of Dhaka | APECE DU

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- ❑ Single-tone Modulation
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Single-tone Modulation

$$m(t) = A_m \cos(2\pi f_m t)$$

$$s(t) = A_c[1 + \mu \cos(2\pi f_m t)]\cos(2\pi f_c t)$$

Modulation Factor

$$\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$$

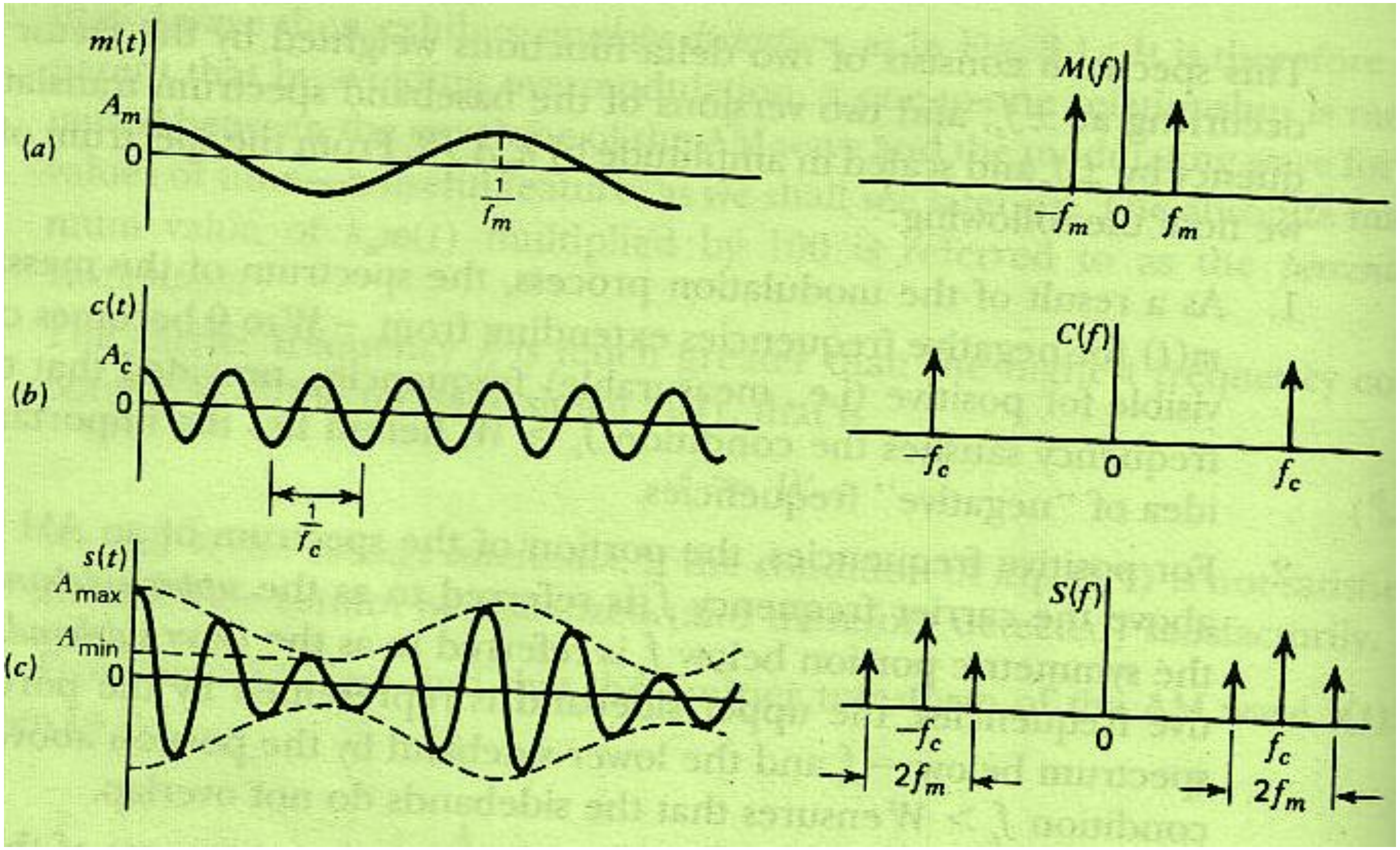
$$s(t) = A_c \cos(2\pi f_c t) + \frac{1}{2}\mu A_c \cos[2\pi(f_c + f_m)t] + \frac{1}{2}\mu A_c \cos[2\pi(f_c - f_m)t]$$

Single-tone Modulation

$$s(t) = A_c \cos(2\pi f_c t) + \frac{1}{2}\mu A_c \cos[2\pi(f_c + f_m)t] + \frac{1}{2}\mu A_c \cos[2\pi(f_c - f_m)t]$$

$$\begin{aligned} S(f) = {} & \frac{1}{2}A_c[\delta(f - f_c) + \delta(f + f_c)] \\ & + \frac{1}{4}\mu A_c[\delta(f - f_c - f_m) + \delta(f + f_c + f_m)] \\ & + \frac{1}{4}\mu A_c[\delta(f - f_c + f_m) + \delta(f + f_c - f_m)] \end{aligned}$$

Single-tone Modulation

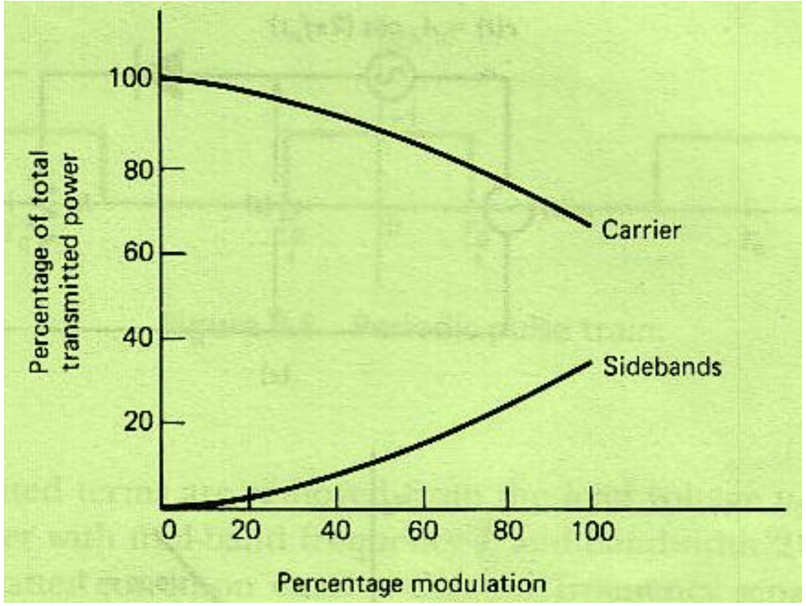


Single-tone Modulation

Carrier power $= \frac{1}{2}A_c^2$

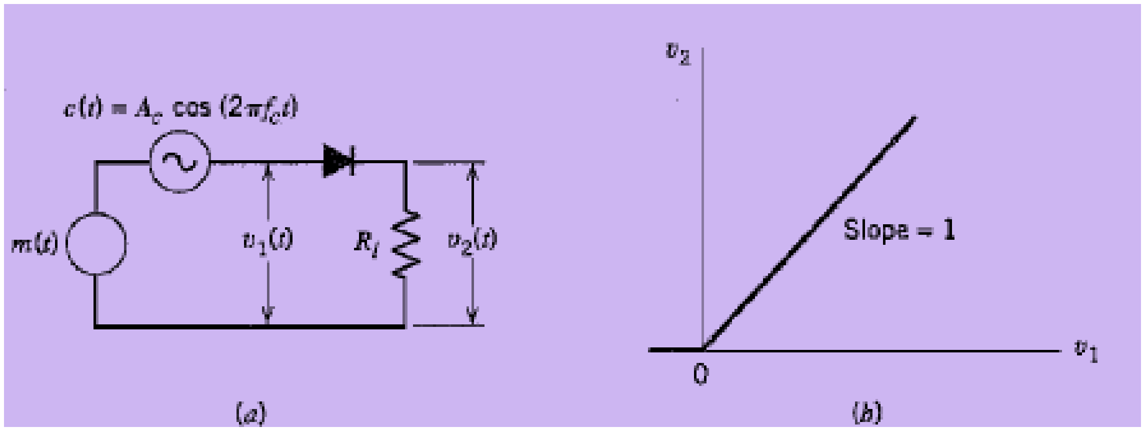
Upper side-frequency power $= \frac{1}{8}\mu^2 A_c^2$

Lower side-frequency power $= \frac{1}{8}\mu^2 A_c^2$



- ??>> Ratio of total side-band power to the total power in the modulated wave
  - ??For 100% modulation

Switching Modulator



$$v_1(t) = A_c \cos(2\pi f_c t) + m(t)$$

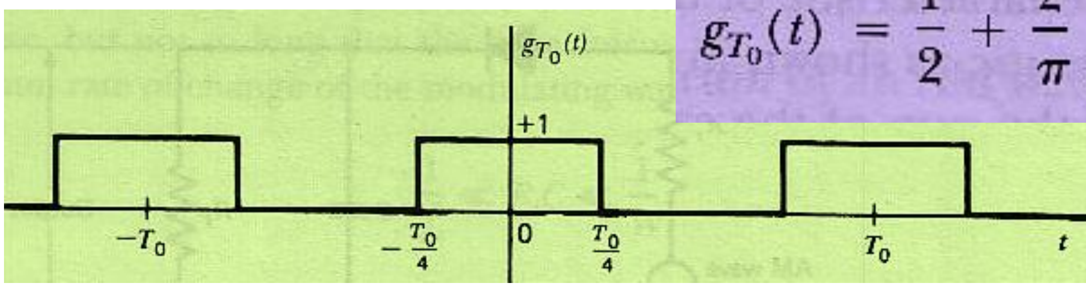
where $|m(t)| << A_c$, the resulting load voltage $v_2(t)$ is

$$v_2(t) \simeq \begin{cases} v_1(t), & c(t) > 0 \\ 0, & c(t) < 0 \end{cases}$$

Switching Modulator

$$v_2(t) \simeq [A_c \cos(2\pi f_c t) + m(t)]\, g_{T_0}(t)$$

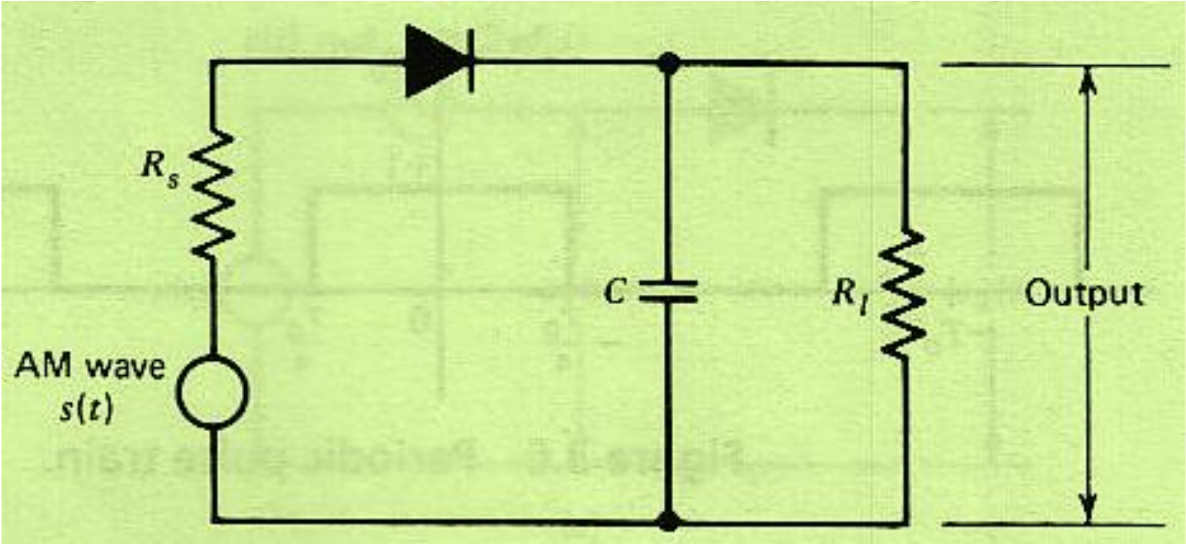
$$g_{T_0}(t) = \frac{1}{2} + \frac{2}{\pi} \sum_{n=1}^{\infty} \frac{(-1)^{n-1}}{2n-1} \cos[2\pi f_c t(2n-1)]$$



$$\frac{A_c}{2}\left[1 + \frac{4}{\pi A_c} m(t)\right] \cos(2\pi f_c t)$$

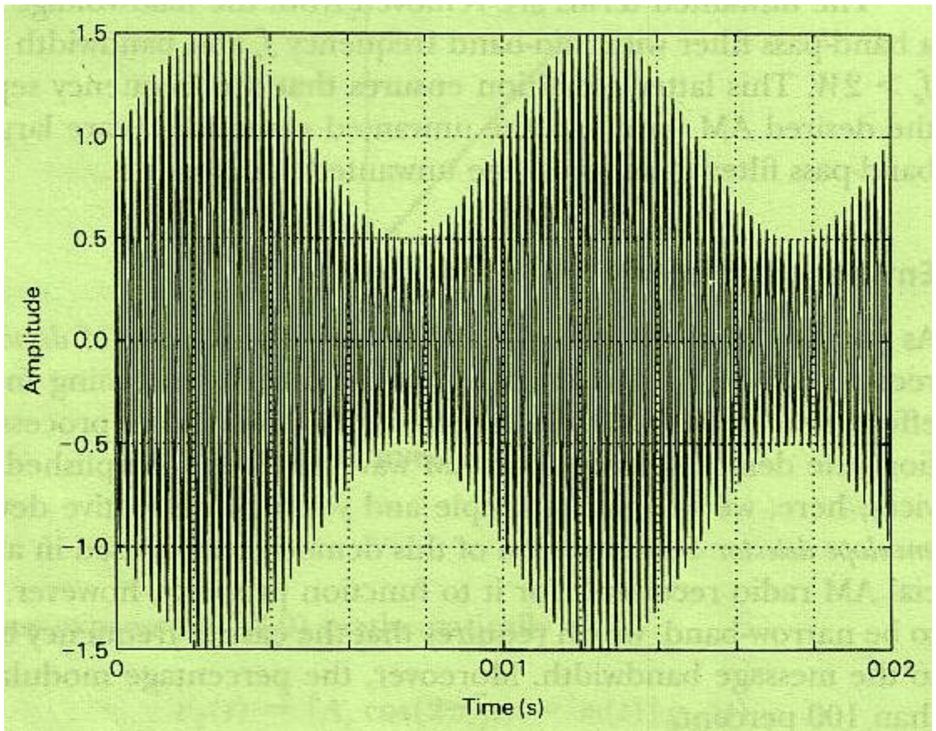
Unwanted components, the spectrum of which contains delta functions at $0, \pm 2f_c, \pm 4f_c$, and so on, and which occupy frequency intervals of width $2W$ centered at $0, \pm 3f_c, \pm 5f_c$, and so on, where W is the message bandwidth.

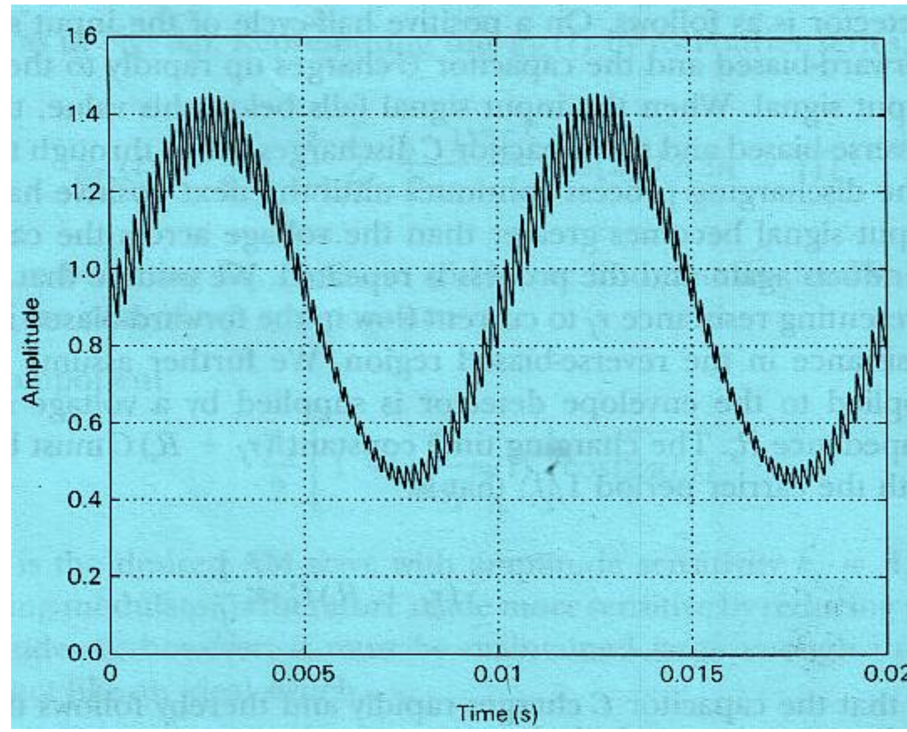
Envelope Detector



$$(r_f + R_s)C \ll \frac{1}{f_c}$$

Envelope Detector





$$\frac{1}{f_c} \ll R_l C \ll \frac{1}{W}$$

Envelope Detector

Source resistance	$R_s = 75\ \Omega$
Forward resistance	$r_f = 25\ \Omega$
Load resistance	$R_l = 10\ k\Omega$
Capacitance	$C = 0.01\ \mu F$
Message bandwidth	$W = 1\ kHz$
Carrier frequency	$f_c = 20\ kHz$

Q & A