Pulse Width Modulation (PWM) and Pulse Position Modulation (PPM)

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Important Instructions

- Try to complete all tasks within 2 hours. After 2 hrs, evaluation starts.
- For each subtask, create mfiles (eg. CT_HT.m) and save them with suitable name.
- Prepare a word document naming your name and ID. In it, save all results including plots.
- In all plots, put x-label, y-label, legend, font 'Arial'(Size = 10), and, Width '2'.

Pulse Width Modulation (PWM)

- In PWM
  - Samples of message signal are used to vary the duration of the individual pulses of pulse train (carrier)
  - Modulating signal may vary the time of occurrence of the leading edge, the trailing edge, or both edges of pulse

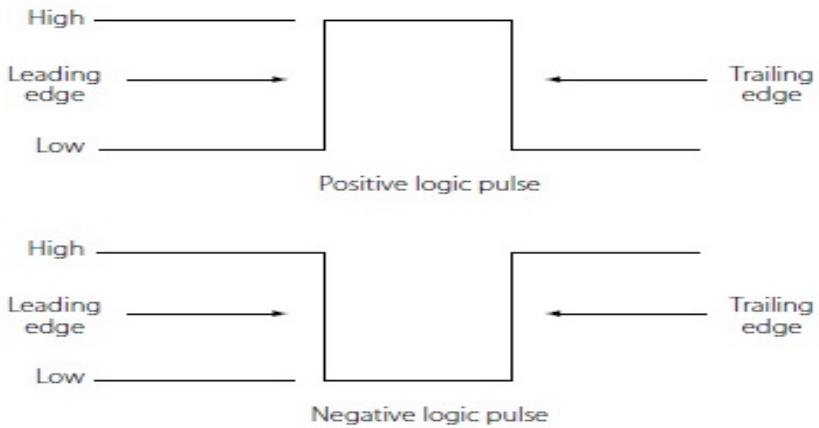

Figure: Positive pulse and Negative pulse.

- Application of PWM
  - Control of power supplied to electrical devices (eg. Motors)
  - Used in communication systems where 'duty cycle' is used to convey information

Pulse Position Modulation (PPM)

- In PPM
  - Samples of message signal are used to vary the position of a pulse relative to its unmodulated time of occurrence
  - In PPM, pulse width remain same, but their locations are non-uniform
- Application of PPM
  - Fiber-optic communication
  - Ultra wideband communication

Pulse Analog Modulation Schemes: An Illustration

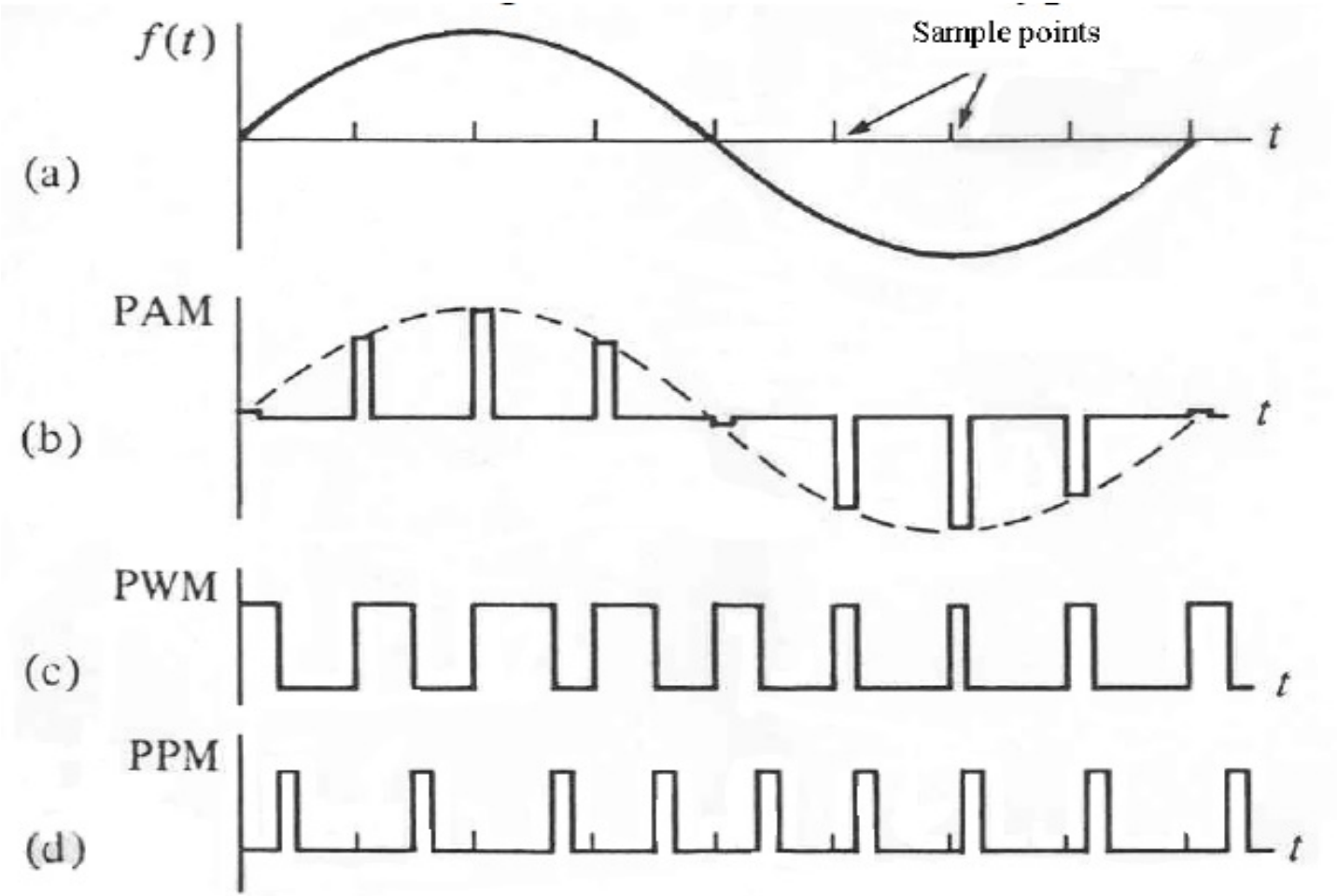

Figure: (a). $f(t)$: Message signal (b). PAM signal (c). PWM signal, and, (d). PPM signal.

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Task 1. (a): PWM and Demodulation

- Understand following library functions/commands
  - eps
  - modulate(x,fc,fs,'pwm','centered')
  - demod(y,fc,fs,'pwm','centered')
- Use the following
  - $f_c = 4000$ Hz;
  - $f_s = 80000$ Hz;
  - $f_m = 900$ Hz;
  - $t_1 = \text{linspace}(0, 4, 900)$;
  - $x = \frac{1+\sin(2\pi f_m t_1)}{2}$;
  - axis for message signal & demodulated signal: axis([0 2 -1.2 1.2]);
  - axis for PWM signal: axis([0 .004 -0.2 1.2]);
- Question:
  1. Write a program to plot original message signal $x(t)$, PWM signal, and, demodulated signal. Use modulate and demod functions in MATLAB. Show all in single plot. In the plot, provide x-label, y-label, title, and legend.

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Task 1. (b): PWM Using Sawtooth

- Use the following
  - $t = 0 : 0.001 : 1;$
  - $s = \text{sawtooth}(20\pi t);$
  - $m(t) = 0.45 \sin(2\pi t);$
  - Hint: Compare message and sawtooth amplitudes. Whenever message amplitude is higher than sawtooth, pulse voltage level should be high. Whenever message amplitude is less than sawtooth, pulse voltage level should be zero
  - axis([0 1 -1.5 1.5]);
- Questions:
  - Write a program to plot original message signal $x(t)$, sawtooth signal, and PWM signal. Show all in single plot. In the plot, provide x-label, y-label, title, and legend.
  - From the PWM signal, graphically determine the ratio of maximum pulse width to the minimum pulse width

Task 2. (a): Pulse Position Modulation (PPM)

- Use the following
  - warning off (optional)
  - $f_c = 8000$ Hz;
  - $f_s = 80000$ Hz;
  - $f_m = 400$ Hz;
  - $t_1 = \text{linspace}(0, 4, 800)$;
  - $x = \frac{1+\sin(2\pi f_m t_1)}{2}$;
  - axis for message signal: axis([0 4 -0.2 1.2]);
  - axis for PPM signal: axis([0 0.004 -0.2 1.2]);
- Questions:
  - Write a program to plot message signal, PPM signal. Use modulate function in MATLAB. Give x-label, y-label, title etc. to all subplots.

Task 2. (b): Pulse Position Modulation (PPM) Contd.,

- Use the following
  - $f_c = 50$ Hz;
  - $f_s = 1000$ Hz;
  - $f_m = 200$ Hz;
  - $t_1 = 0 : \frac{1}{f_s} : (\frac{2}{f_m} - \frac{1}{f_s})$;
  - $x = 0.4\cos(2\pi f_m t_1) + 0.5$;.
- Questions:
  - Write a program to plot message signal, PPM signal, and demodulated signal. Use modulate, demod functions in MATLAB. Give x-label, y-label, title etc. to all subplots.

Topic to Explore

- PULSE DENSITY MODULATION