Code	**STANDING_WAVE_RATIO.PY**
Author	Nathaniel Heatwole, PhD (heatwolen@gmail.com) (GitHub) (LinkedIn)
Summary	Reproduces the design and likeness of a SWR/Watt cross-needle meter for assessing power levels and extent of mismatch for transmission lines.

Methods/ process	Standing wave ratio (SWR):
	- Assesses extent of mismatch between a transmission line and its load.
	- Unitless (ratio), SWR ≥ 1, with greater values indicating less good matches.[1]
	- Can be computed using (see reflection coefficient):
	   - *Forward power (Watts)*: emanating from the transmitter.
	   - *Reflected power (Watts)*: not accepted by the load (and reflected back to the transmitter).
	- Extrema:
	   - *SWR = 1* -> perfect match, indicating all forward power reaches and is accepted by the load (reflected power = 0).
	   - *SWR = ∞* -> perfect mismatch, indicating 100% of the forward power is reflected back (reflected power = forward power).
	- Cross-needle SWR/Watt meter (see Figure 2), which is placed in the transmission line, simultaneously measures:
	   - *Forward power* (right needle).
	   - *Reflected power* (left needle).
	   - *SWR* (point where the two needles cross).
	
	Steps:
	1. Generate the power curves (forward and reflected), as overlapping semi-circles.
	2. Generate the two needles (each rotating about a particular point).
	3. Generate the SWR curves, by looping over SWR and power level combinations, and simultaneously solving multiple equations for the coordinates where the two needles cross (2 equations / 2 unknowns).
	4. Demonstrate the functionality of the meter with various example scenarios.

Input	User-specified SWR levels, power ranges, and power increments.
Output	Plots – meter with: - Needles at rest ("first positions") - Needles at maximums - Maximum forward power / perfect match - Forward power 150 Watts / SWR = 2 (reflected power ~17 Watts) - Needles omitted
Results	Reproduces the likeness and functionality of the cross-needle meter well.

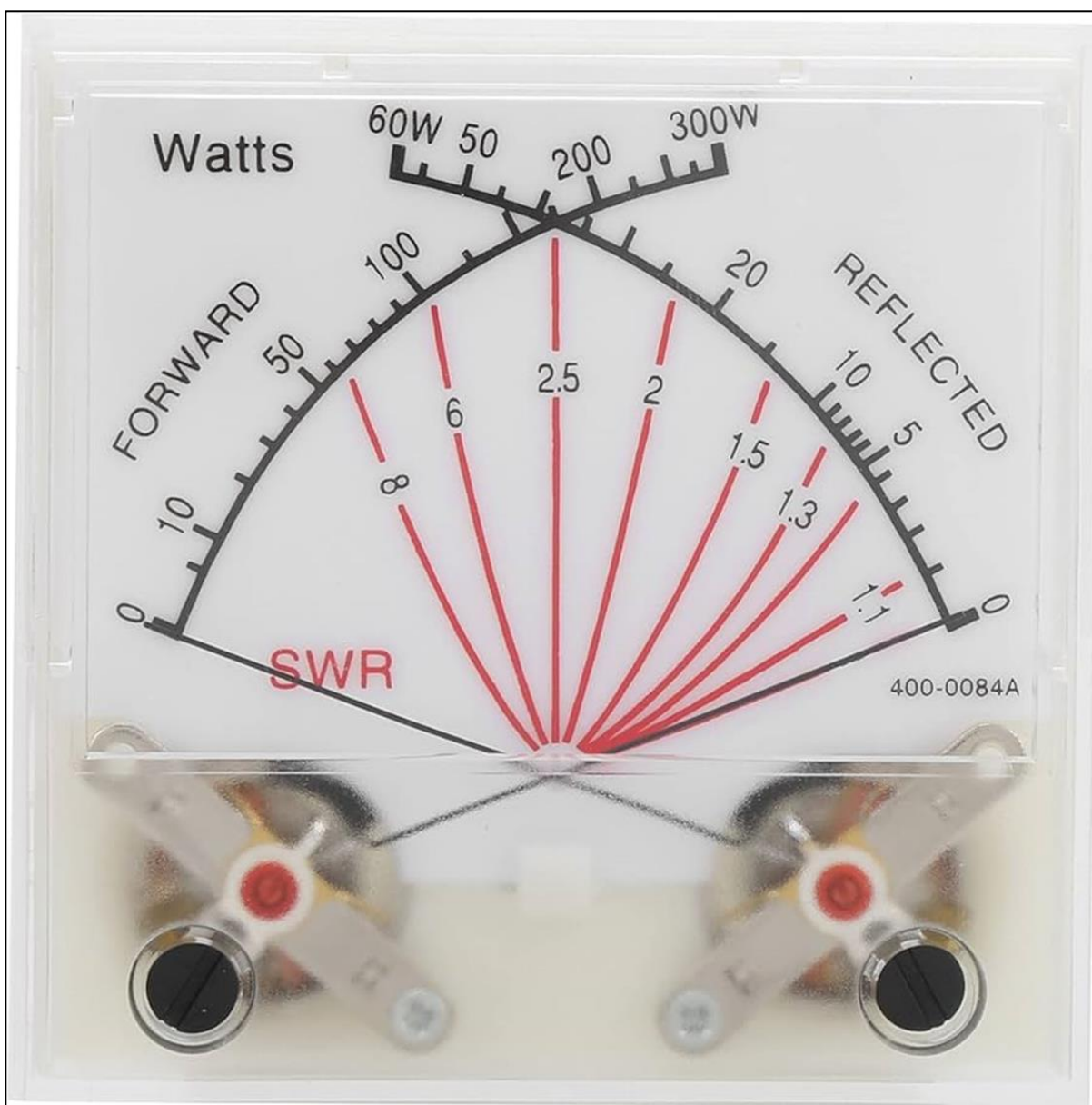[1] SWR are sometimes expressed in relative terms – e.g., SWR = 3 becomes 3:1 ("three-to-one").

Figure 1: SWR/Watt cross-needle meter for assessing transmission line matches and power levels[2]