Homework 2 – RF Electronic Warfare

Name: ______________________________

Instructions and Grading Policy

Instructions:
Part 1 walks you, *individually*, through one complete emitter geolocation — the same pipeline your group runs across many cuts and emitters in Project 2, here for a single condition. If you can do this page by hand, you can sanity-check everything your group's code produces. Part 2 exercises the wider RF EW toolkit from Block 2. You may reference course notes and the Project 2 handout, but all work must be your own. **Use of GenAI is not authorized for any part of this assignment.**

Grading Policy:

- Each question is worth **1 point**, graded on the boxed number only. Total possible points: **10**.
- Report numeric answers to **three significant figures**. Include the sign on bearings.
- If a question does not meet standard, you may submit **one resubmission per question** to recover the full point.

Condition Bravo

A B-21 on a standoff leg geolocates a single threat emitter. Positions are in a local North/East grid (km). The emitter is at $(N, E) = (0, 0)$. The aircraft takes a bearing from two waypoints:

$$\text{WP1} = (-48,\ -14)\ \text{km}, \qquad \text{WP2} = (-48,\ +14)\ \text{km}.$$

The RWR bearing noise is $\sigma_\theta = 0.5^\circ$ (1σ). Bearings are measured from North toward East,

$$\theta = \text{atan2}(\Delta E,\ \Delta N), \qquad \Delta N = N_e - N_r,\ \ \Delta E = E_e - E_r.$$

Part 1 — Geolocate the emitter, step by step

Questions 1–6 build the fix one piece at a time. Keep each intermediate result; you will reuse them. *Work σ_θ in radians where a formula calls for it.*

Q1. Range to the emitter. Compute the slant range from WP1 to the emitter, $R = \sqrt{\Delta N^2 + \Delta E^2}$, in km.

Answer: [ ] **km**

Q2. Bearing from WP1. Compute the bearing (angle of arrival) from WP1 to the emitter, in degrees.

Answer: [ ] **deg**

Q3. Bearing from WP2. Compute the bearing from WP2 to the emitter, in degrees (mind the sign).

Answer: [ ] **deg**

Q4. Crossing (cut) angle. The two bearing lines meet at the fix. Compute the crossing angle between them, $\beta = |\theta_1 - \theta_2|$, in degrees.

Answer: [ ] **deg**

Q5. Cross-range error. A single bearing of accuracy σ_θ at range R pins the emitter across the line of sight to $e_{\mathrm{cr}} = R\,\sigma_\theta$. Compute it, in meters.

Answer: [ ] **m**

Q6. Down-range error. Along the line of sight the fix is worse, and the shallower the cut the worse it gets. For this symmetric two-bearing geometry the down-range semi-axis of the error ellipse is

$$a = \frac{R\,\sigma_\theta}{\sqrt{2}\,\sin(\beta/2)}.$$

Compute a, in meters.

Answer: [ ] **m**

Part 2 — The wider RF EW toolkit

Q7. Open the cut. Suppose a longer baseline widens the cut to $\beta = 60^\circ$ at the same 50 km range. Recompute the down-range semi-axis a with the Q6 formula, in meters. (Compare to Q6: a wider cut shrinks the range error.)

Answer: [ ] **m**

Q8. Processing gain. A B-21 protected datalink spreads each bit over $N = 100$ chips. Compute its processing gain $G_p = 10\log_{10} N$, in dB. (A jammer at $J/S = +12$ dB leaves you about 8 dB of margin — but only the boxed number is graded.)

Answer: [ ] **dB**

Q9. Burn-through range. A self-protect jammer faces a threat radar with $P_t = 1$ MW, $G_t = 10^4$, target RCS $\sigma = 5$ m^2, jammer $P_j = 40$ W, $G_j = 1$. Burn-through (where $J/S = 1$) occurs at

$$R_{bt} = \sqrt{\frac{P_t\, G_t\, \sigma}{4\pi\, P_j\, G_j}}.$$

Compute R_{bt}, in km.

Answer: [ ] **km**

Q10. Range-gate pull-off. A DRFM walks its false return outward at an apparent range-rate of 1000 m/s for 1.5 s before blinking off. Compute the pull-off distance, in meters. (The radar's range gate is 150 m wide — so the true target ends up well outside it.)

Answer: [ ] **m**