1. (20 pts.) At time $t = 0$ hours aircraft A is 200 km north of radar site B. The course and speed of aircraft A is 150° at 250 km/hour. This means that CPA occurs at time $100\sqrt{3}/250$ hours at a bearing of 060°. Aircraft A is detected by the radar site at a rate of $10000/r(t)^2$ detections/hours, where $r(t)$ is the range at time t in kilometers. Set up the integral to evaluate the probability of a detection between time 0 and the time of CPA.

2. (20 pts.) If a target makes <u>one</u> crossing of the first convergence zone (CZ), it is detected with probability .4. If this target comes within 4 nm of the sensor, it is detected with probability .7. The range to the first CZ is 30 nm. Assume that the events of detection are probabilistically independent, and detection is impossible except in the first CZ and inside 4 nm.

(a) (10 pt.) What is the sweep width of this sensor?

(b) (5 pt.) If this sensor conducts a 12 kt random search of an area of size 1000 nm^2, what is the resulting probability of detecting a stationary target during the first hour of search?

(c) (5 pt.) Assuming the search begins again with another unlocated target immediately after each detection, what is the expected number of detections during the first 5 hours of search?

3. (30 pts.) Answer each question T for true or F for false. Each question is worth 2 points.

(a) ( ) Probability of detection is largest when the target penetrates at the center of a barrier.

(b) ( ) When using the random search model for area search, it <u>is not</u> necessary to specify the target's location distribution to calculate P_d.

(c) ( ) When using the exhaustive search model for area search, it <u>is</u> necessary to specify the target's location distribution to calculate P_d.

(d) ( ) The barrier search formula $P_d = \min\{1, (2R/L)\sqrt{1 + (v/u)^2}\}$ overestimates the P_d for targets crossing the barrier near the edge of the channel.

(e) ( ) If the target is uniformly distributed over the search area, then the mean time to detect using the random search model is the search completion time using the exhaustive search model.

(f) ( ) In the Continuously Looking Model with a constant detection rate, the expected number of detections during an interval of length l is proportional to l.

(g) ( ) In a Random Search that has progressed to the point where the expected number of detections is 1, then the P_d is $1 - e^{-1}$.

(h) ( ) In the Archimedes Spiral Search, the distance to datum always increases linearly with time.

(i) ( ) In the Log Spiral Search, the distance to datum increases by a constant amount with each revolution by the searcher.

(j) ( ) A target is trapped inside a circle of radius $(\rho - R)$ if it can not move more than $2R$ during the time it takes the searcher to complete one revolution about a circle of radius ρ.

(k) ( ) A "square-law detector" gives a detection when the average value of the square of the signal meets or exceeds a specified threshold value.

(l) ( ) A square-law detector is more sensitive than is a linear-law detector.

(m) ( ) "Detection index" increases as the signal-to-noise ratio (SNR) increases.

(n) ( ) In the radar equation, maximum detection range is proportional to $P_t^{(1/4)}$, where P_t is transmitter peak power.

(o) ( ) If the base frequency is 10 GHz and the relative speed between the searcher and the target is 100 meters/sec opening, the frequency of the return echo is approximately 10 GHz + 6670 Hz.

4. (30 pts.) Naval gunfire support is aimed at (0 km, 0 km). The impact points are independent BVN random variables with means at the aim point and variances $\sigma_x^2 = .09$ km^2 and $\sigma_y^2 = .25$ km^2. Spotters are located at (1 km, 1 km). If 10 rounds are fired, what is probability that one or more rounds land 50 meters or less from the spotters. Express your answer in terms of the standard normal cumulative distribution function, Φ.