Name: _____

Score: _____ / _____

Week 4 Homework

Part 1

1

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

A flaming datum occurs at a port at time -tau. The target flees away at 20 kts. Since the target can only flee via water, it can take any heading between 0 and 180. A searcher with speed 100 kts and sweepwidth 15 nm arrives to the AOR at time 0 to perform random search. What is the maximum value of tau to guarantee the escape probability is less than 0.2? ____

Answer Point Value: 1.0 points
Answer Key: 1.48|1.50
Correct Feedback:

```
> #standard expnading area random search with a half circle instead of full cirlce
> #A(t)= pi/2*(u(t+tau))^2

#mathematically equivalent to doubling the sweepwidth or velocity
> w = 15
> v = 100
> u = 20
> desiredPd = 0.2
> (tau = -2*w*v/(log(desiredPd)*pi*u^2))
[1] 1.483328
> ( exp(-2*w*v/(pi*u^2*tau)))
[1] 0.2
```

Incorrect Feedback:

```
> #standard expnading area random search with a half circle instead of full cirlce
> #A(t)= pi/2*(u(t+tau))^2
#mathematically equivalent to doubling the sweepwidth or velocity
> w = 15
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[1] 1.483328
> ( exp(-2*w*v/(pi*u^2*tau)))
[1] 0.2
```

2

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

A flaming datum occurs at a port. The target flees away at 20 kts. Since the target can only flee via water, he can take any heading between 0 and 180. A searcher with speed 100 kts and sweepwidth 15 nm arrives to the AOR at time-late 1 hour to perform random search. How long should the search last to achieve 0.9 of the maximum detection probability? ____

Answer Point Value: 1.0 points
Answer Key: 2.45|2.5
Correct Feedback:

```
> #standard expnading area random search with a half circle instead of full cirlce
> #A(t)= pi/2*(u(t+tau))^2
#mathematically equivalent to doubling the sweepwidth or velocity
> #use slide 14 on h12. any time we see w, replace with 2w
> w = 15
> v = 100
> u = 20
> alpha = 0.9
> tau = 1
>
> (talpha = 2*w*v/(pi*u^2)/(log((1-alpha)*exp(2*w*v/(pi*u^2*tau))+alpha))-tau)
[1] 2.473245
> (maxPd= 1-exp(-2*w*v/(pi*u^2*tau)))
[1] 0.9081248
> (Pd = 1-exp(-2*w*v/(pi*u^2)*(1/tau-1/(tau+talpha))))
[1] 0.8173123
> (Pd/maxPd)
[1] 0.9
```

Incorrect Feedback:

```
> #standard expnading area random search with a half circle instead of full cirlce
> #A(t)= pi/2*(u(t+tau))^2
#mathematically equivalent to doubling the sweepwidth or velocity
> #use slide 14 on h12. any time we see w, replace with 2w
> w = 15
> v = 100
> u = 20
> alpha = 0.9
> tau = 1
>
> (talpha = 2*w*v/(pi*u^2)/(log((1-alpha)*exp(2*w*v/(pi*u^2*tau))+alpha))-tau)
```

```
[1] 2.473245
> (maxPd= 1-exp(-2*w*v/(pi*u^2*tau)))
[1] 0.9081248
> (Pd = 1-exp(-2*w*v/(pi*u^2)*(1/tau-1/(tau+talpha))))
[1] 0.8173123
> (Pd/maxPd)
[1] 0.9
```

3

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

Datum occurs involving a target with speed 10 kts. The searcher has speed 150 kts and detection range of 20 nm. What is the maximum radius the searcher can perform a trapping circle? ____

Answer Point Value: 1.0 points
Answer Key: 95|96
Correct Feedback:

```
> u = 10
> v = 150
> R = 20
> (rhoMax = R*v/(pi*u))
[1] 95.49297
```

Incorrect Feedback:

```
> u = 10
> v = 150
> R = 20
> (rhoMax = R*v/(pi*u))
[1] 95.49297
```

4

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

Datum occurs involving a target with speed 10 kts. The searcher has speed 150 kts and detection range of 20 nm. What is the maximum time-late the searcher can arrive to the AOR and still trap the target in a circle? ____

Answer Point Value: 1.0 points
Answer Key: 7.5|7.6
Correct Feedback:

```
> u = 10
> v = 150
> R = 20
> (tauMax = R/u*(v/(pi*u)-1))
[1] 7.549297
```

Incorrect Feedback:

```
> u = 10
> v = 150
> R = 20
> (tauMax = R/u*(v/(pi*u)-1))
[1] 7.549297
```

5

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

Datum occurs involving a target with speed 10 kts. The searcher has speed 150 kts and detection range of 20 nm. The searcher has a maximum on-station time of 4 hours to find the target. Operationally what is the latest the searcher can arrive to the area to ensure it can spiral in to detect the target during its on-station time? ____

Answer Point Value: 1.0 points
Answer Key: 4.3|4.5
Correct Feedback:

```
> #endurance is 4 hours.
> #must be able to spiral in and find target in 4 hours.
> #thus tMax = 4
> #find rho0 that allows searcher to spiral in 4 hours
> u = 10
> v = 150
> R = 20
> (rhoMax = R*v/(pi*u))
[1] 95.49297
> rho0=64.2509
> (tMAx = 1/u*(rhoMax*log((rhoMax-R)/(rhoMax-rho0))-rho0+R))
[1] 4.000006
>
> #Now compute the operational time late that will allow us to trap target at radius 64.25
> (tauStar = (rho0-R)/u)
[1] 4.42509
```

Incorrect Feedback:

```
> #endurance is 4 hours.
> #must be able to spiral in and find target in 4 hours.
> #thus tMax = 4
> #find rho0 that allows searcher to spiral in 4 hours
> u = 10
> v = 150
> R = 20
> (rhoMax = R*v/(pi*u))
[1] 95.49297
> rho0=64.2509
> (tMAx = 1/u*(rhoMax*log((rhoMax-R)/(rhoMax-rho0))-rho0+R))
[1] 4.000006
>
```

```
> #Now compute the operational time late that will allow us to trap target at radius 64.25
> (tauStar = (rho0-R)/u)
[1] 4.42509
```

6

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

Searcher has speed 30 kts and range 15 nm. Target has speed 10 kts and counter-detection range 40 nm. The target wants to avoid the searcher. What is the effective sweepwidth of the searcher? ____

Answer Point Value: 1.0 points
Answer Key: 3.5|3.6
Correct Feedback:

```
> v = 30
> Rs=15
> u = 10
> Rt=40
> #evasion equation
> 2*Rt*sin(acos(u/v)-acos(Rs/Rt))
[1] 3.56361
```

Incorrect Feedback:

```
> v = 30
> Rs=15
> u = 10
> Rt=40
> #evasion equation
> 2*Rt*sin(acos(u/v)-acos(Rs/Rt))
[1] 3.56361
```

7

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

Searcher has speed 30 kts and range 15 nm. Target has speed 10 kts and counter-detection range 40 nm. The target wants to avoid the searcher. How fast must the target go to always avoid detection? ____

Answer Point Value: 1.0 points
Answer Key: 11.2|11.3
Correct Feedback:

```
> v = 30
> Rs=15
> u = 10
> Rt=40
> #evasion condition
> (v*Rs/Rt)
[1] 11.25
```

Incorrect Feedback:

```
> v = 30
> Rs=15
> u = 10
> Rt=40
> #evasion condition
> (v*Rs/Rt)
[1] 11.25
```

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

Searcher has speed 30 kts and range 15 nm. Target has speed 10 kts and counter-detection range 40 nm. The target wants the searcher to find it. What is the effective sweepwidth of the searcher? ____

Answer Point Value: 1.0 points
Answer Key: 52.8|53.5
Correct Feedback:

```
> v = 30
> Rs=15
> u = 10
> Rt=40
> #check that target cannot always catch up to searcher
> (u/v)
[1] 0.3333333
> (sqrt(1-(Rs/Rt)^2))
[1] 0.9270248
> #approach equation
> 2*Rt*sin(pi-acos(u/v)-acos(Rs/Rt))
[1] 53.00493
```

Incorrect Feedback:

```
> v = 30
> Rs=15
> u = 10
> Rt=40
> #check that target cannot always catch up to searcher
> (u/v)
[1] 0.3333333
> (sqrt(1-(Rs/Rt)^2))
[1] 0.9270248
> #approach equation
> 2*Rt*sin(pi-acos(u/v)-acos(Rs/Rt))
[1] 53.00493
```

Accepted characters: numbers, decimal point markers (period or comma), sign indicators (-), spaces (e.g., as thousands separator, 5 000), "E" or "e" (used in scientific notation). **NOTE:** For scientific notation, a period MUST be used as the decimal point marker.

A searcher traveling at 25 kts performs barrier search across a channel 120 nm in length. The target travels at 5 kts. What is the minimum detection range for the searcher such that the probability of detection will exceed 0.8?

____

Answer Point Value: 1.0 points
Answer Key: 9.35|9.5
Correct Feedback:

```
> v=25
> u=5
> L = 120
> desiredPd = 0.8
> (R=desiredPd*L/2*1/sqrt(1+(v/u)^2))
[1] 9.413574
> (min(1,2*R/L*sqrt(1+(v/u)^2)))
[1] 0.8
```

Incorrect Feedback:

```
> v=25
> u=5
> L = 120
> desiredPd = 0.8
> (R=desiredPd*L/2*1/sqrt(1+(v/u)^2))
[1] 9.413574
> (min(1,2*R/L*sqrt(1+(v/u)^2)))
[1] 0.8
```

10

A searcher performing barrier search can travel at one of 4 speeds: 10, 15, 20, 25. Each velocity corresponds to a different sweepwidth. What velocity should the searcher choose to maximize the probability of detecting a target traveling at 12 kts in a 50 nm channel?

v (kts)	10	15	20	25
w (nm)	20	18	15	12

- A. 10 Feedback: --------
- B. 15 Feedback: --------
- C. 20 Feedback: --------
- D. 25 Feedback: --------

Answer Point Value: 1.0 points
Answer Key: C
Correct Feedback:

```
> vVec=c(10,15,20,25)
> wVec = c(20,18,15,12)
> u=12
> L = 50
> (PdVec= wVec/L*sqrt(1+(vVec/u)^2))
[1] 0.5206833 0.5762812 0.5830952 0.5546170
> (vVec[which.max(PdVec)])
[1] 20
```

Incorrect Feedback:

```
> vVec=c(10,15,20,25)
> wVec = c(20,18,15,12)
> u=12
> L = 50
> (PdVec= wVec/L*sqrt(1+(vVec/u)^2))
[1] 0.5206833 0.5762812 0.5830952 0.5546170
> (vVec[which.max(PdVec)])
[1] 20
```