Homework #10 John Taque

6.3.13 Consider a standard, 19-element hexagonal array in the xy-plane.

(a) Desired signal arrives from $\theta = 0°$

(b) 2 interference sources:

(i) $u_r = 0.5$ and $\phi = 0°$

(ii) $u_r = 0.5$ and $\phi = 30°$

(iii) INR = 20 dB/source

(1) Design an MPDR beamformer and compute the array gain.

Solution:

$$\underline{w} = \underline{S_x}^{-1} \underline{v_m} / (\underline{v_m}^H \underline{S_x}^{-1} \underline{v_m})$$

In this problem, $\underline{v_m} = \underline{v_s}$ and

$$\underline{S_x} = \sigma_s^2 \underline{v_s}\underline{v_s}^H + 100 \underline{v_1}\underline{v_1}^H + 100 \underline{v_2}\underline{v_2}^H + \underline{\underline{I}}$$

Without loss of generality, set $\sigma_s^2 = 1$

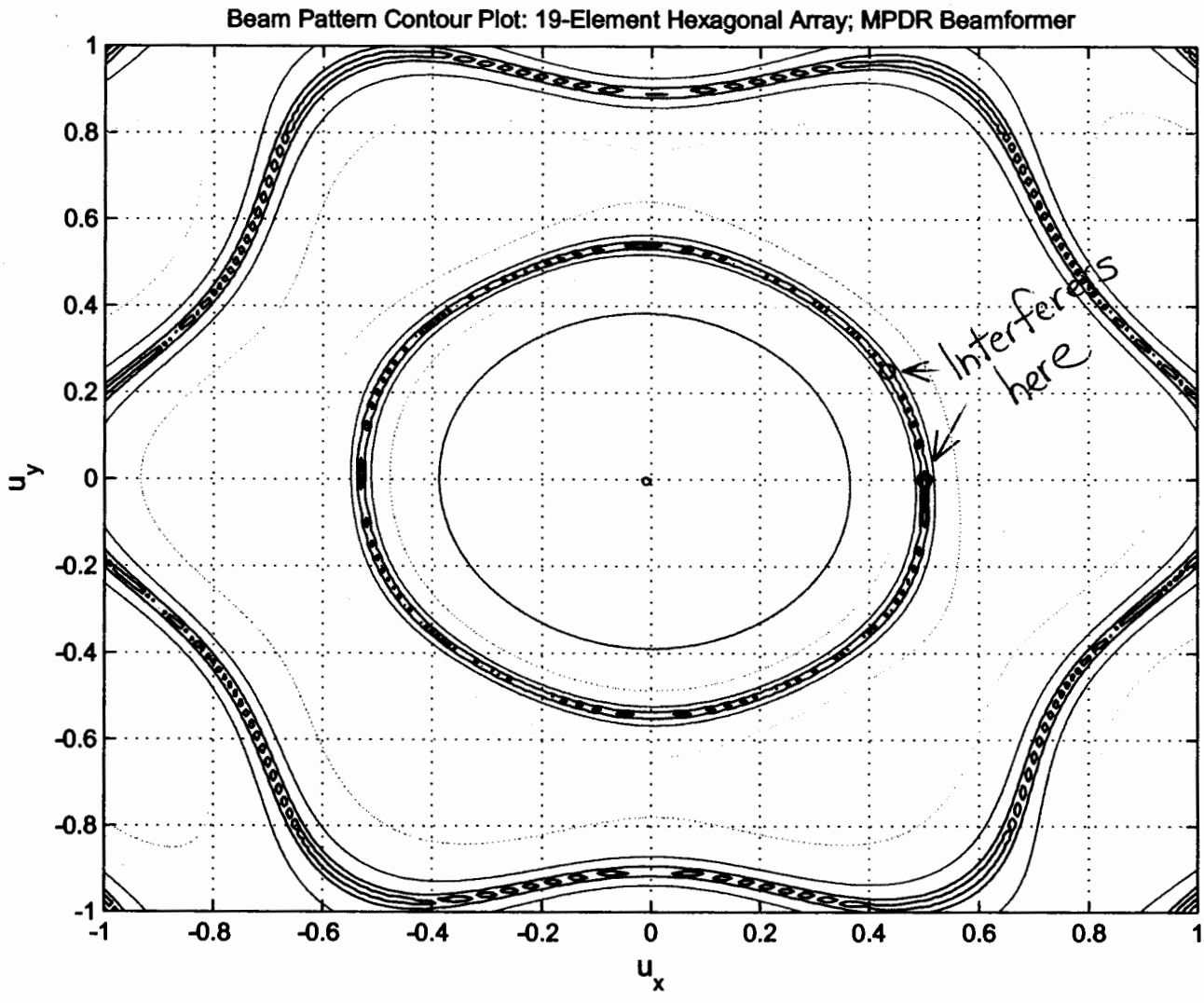
I wrote the code to generate array manifold vectors for the desired

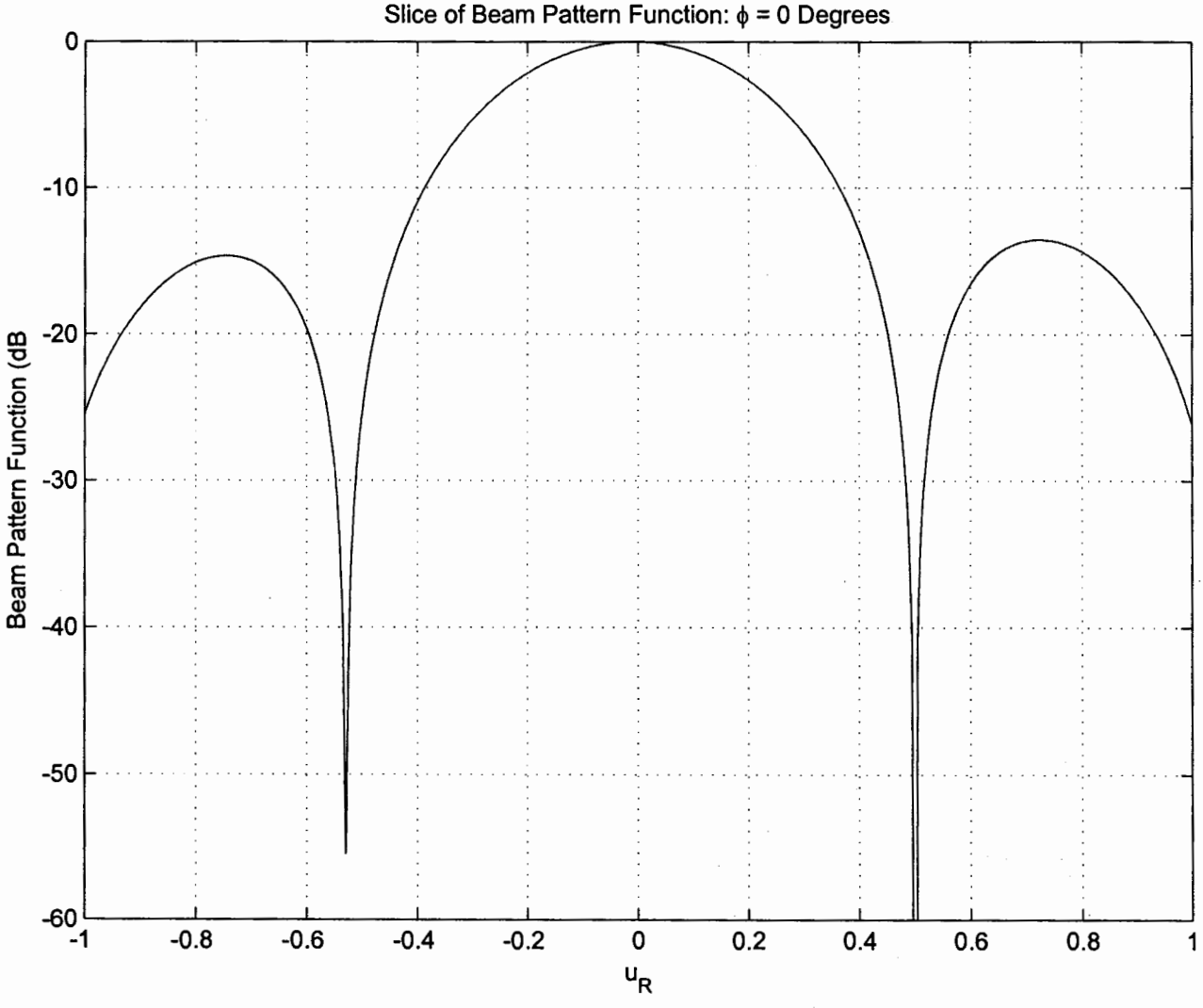
signal and the interferers.

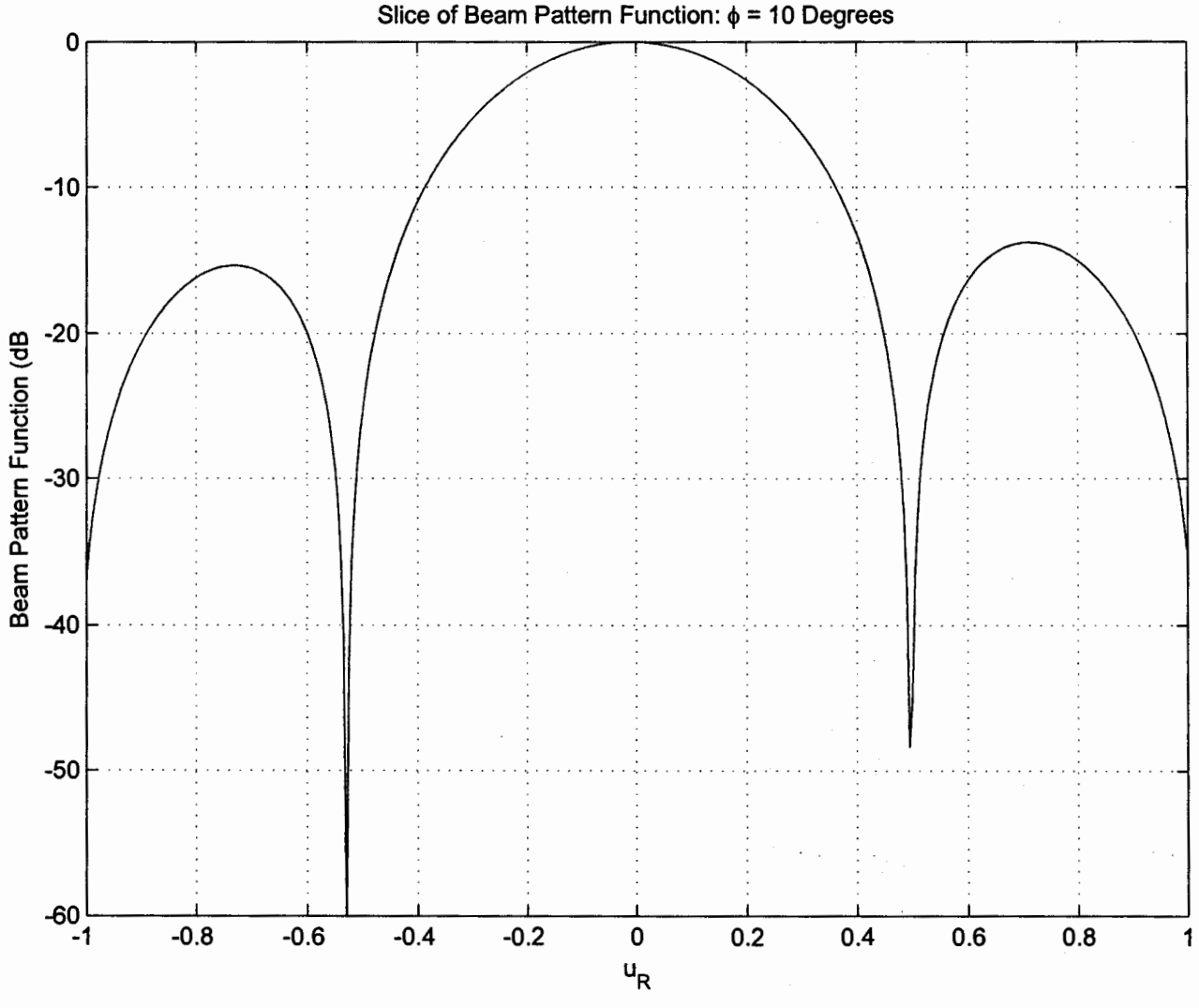
I then computed $\underline{w}$ and plotted the beam pattern. The nulls are in the right places and they moved when I changed the DOA's of the interferers.

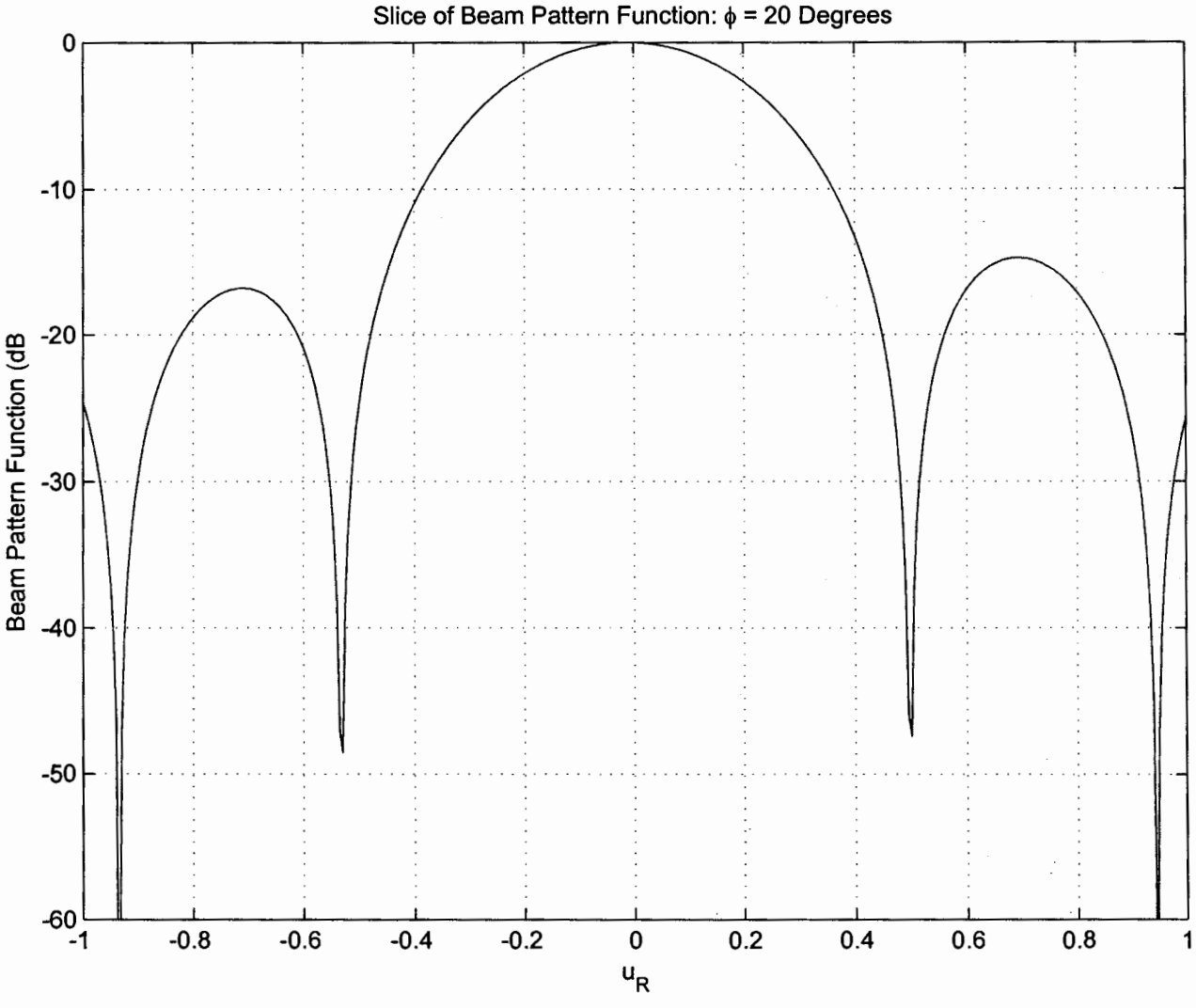
The array gain is 35.8 dB.

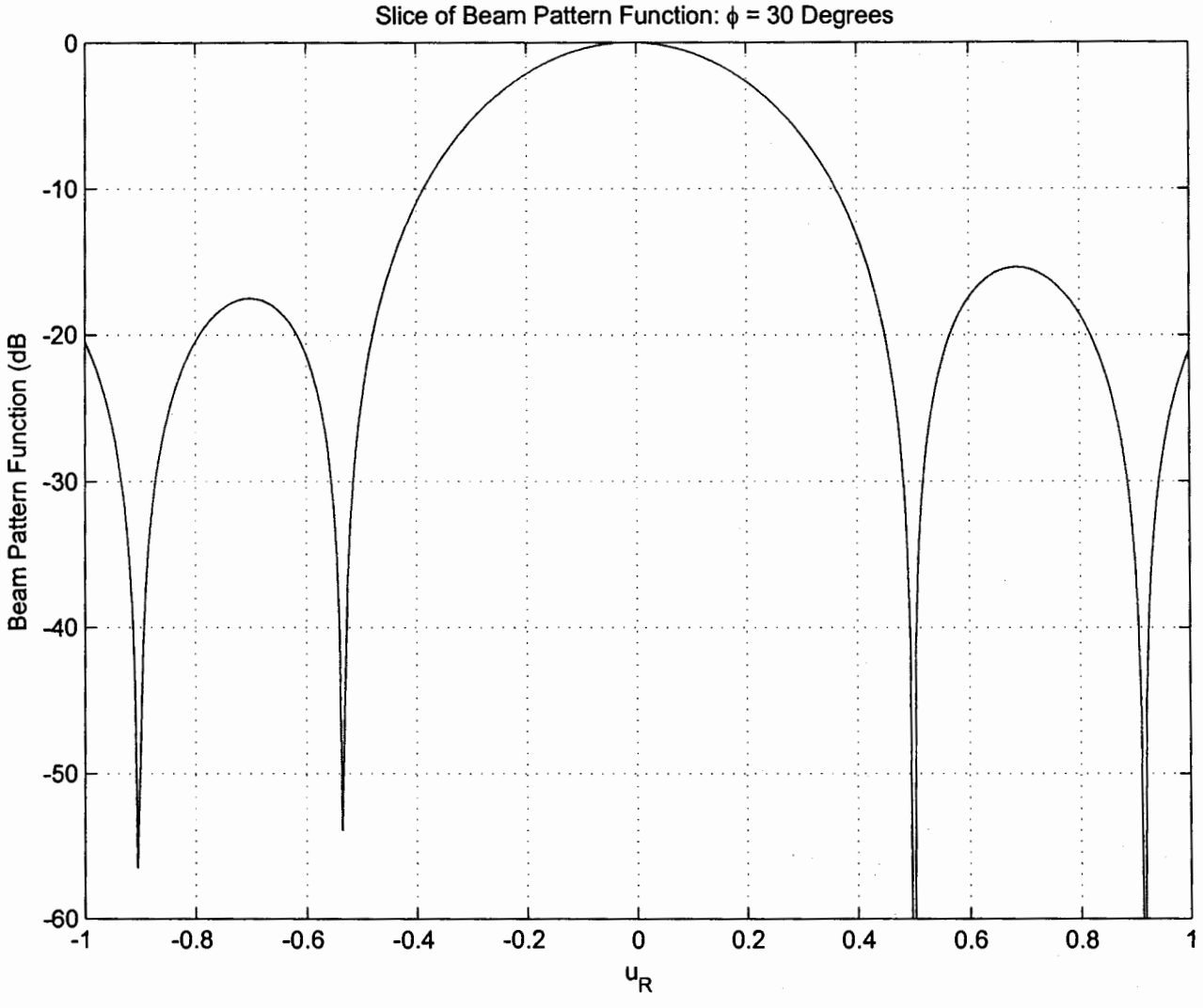
To make the contour plots I evaluated $B(u_x, u_y)$ for $u_x = u_R \cos\phi$ and $u_y = u_R \sin\phi$ for $\phi = 0, 10, 20$ and $30°$ and $-1 \leq u_R \leq +1$. The plots are attached.


Beam Pattern Contour Plot: 19-Element Hexagonal Array; MPDR Beamformer
Interferers here
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
u_y
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
u_x


Slice of Beam Pattern Function: ϕ = 0 Degrees
Beam Pattern Function (dB
0
-10
-20
-30
-40
-50
-60
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
u_R


Slice of Beam Pattern Function: ϕ = 10 Degrees
Beam Pattern Function (dB
0
-10
-20
-30
-40
-50
-60
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
u_R


Slice of Beam Pattern Function: ϕ = 20 Degrees
Beam Pattern Function (dB
0
-10
-20
-30
-40
-50
-60
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
u_R


Slice of Beam Pattern Function: ϕ = 30 Degrees
Beam Pattern Function (dB
0
-10
-20
-30
-40
-50
-60
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
u_R