Antenna 2017

Problem 3 (5%) - **Antenna Theory and Techniques**

Find the half-power beamwidth (HPBW) and the first null beamwidth (FNBW), in degrees for the radiation intensity: $U(\theta) = 2sin^3(2\theta)$

Problem 4 (20%) - **Antenna Theory and Techniques**

Consider a small satellite with dimensions 10 x 10 x 10 cm which transmits 2 Watt.

2.a (2%) What is the transmit power in dBW and dBm?

2.b (2%) If both the receiving and transmitting antenna radiate isotropic and the distance to the ground antenna is 600 KM what is the received power?

2.c (10%) If the receiving antenna has a gain of 30 dBi what is the maximum power it could receive if the antenna on the satellite has the highest gain on the 10 x 10 cm area at 2 GHz?

2.d (6%) For the system described in 3.c) consider a more realistic situation with an VSWR of 1.3 for the satellite antenna and an area efficiency of the satellite antenna of 70%. How much should the transmitter power be increased to still allow a 2 Watt transmission from the small satellite?

Problem 3

```
syms t
expr = 2*sin(2*t)^3;
HPBW = solve(expr == 1/2,t);
vpa(HPBW);
y = [0.34075119084070677047793171607945 1.2300451359541898487533899755603];
rad2deg(y(1,2)-y(1,1));
% For First null beamwidth så bruger vi chats svar istedet
```

Solution:

The First Null Beamwidth is the angular width between the points where the radiation intensity $U($ drops to zero (i.e., the nulls of the main lobe).

1. **Set $U(\theta) = 0$:** Solve $2\sin^3(2\theta) = 0$. Simplify to:

$$\sin(2\theta) = 0$$

2. **Find the nulls:** The solutions to $\sin(2\theta) = 0$ are:

$$2\theta = n\pi \quad \text{(where } n \text{ is an integer)}$$

   So, $\theta = \frac{n\pi}{2}$.

   The first nulls occur at $\theta = \frac{\pi}{4}$ and $\theta = -\frac{\pi}{4}$. The angular width between these two nulls is:

$$\text{FNBW} = \frac{\pi}{4} - \left(-\frac{\pi}{4}\right) = \frac{\pi}{2} \text{ radians (or } 90^\circ\text{)}.$$

Problem 4

2.a: Solution:

```
antenna_size = 10*10*10;
Powert = 2;
powerDb = pow2db(Powert); %dBW
dBWtodBm = 30 + powerDb;
```

2.b Hvor helvede er den her formel? Solution:

```
receiveGain = 30 %dbi
```

```
receiveGain =
    30
```

$$D_t = G = \frac{4\pi\eta A}{\lambda^2} \qquad \frac{P_r}{P_t} = \lambda^2 \cdot \frac{D_r \cdot D_t}{(4 \cdot \pi \cdot R)^2}$$

2.c Solution:

```
Gt = (4*pi*1*0.1*0.1)/((3e8/2e9)^2);
Gr = db2pow(receiveGain);
Pr = Powert*(3e8/2e9)^2 * ((Gt*Gr)/(4*pi*600E3)^2);
picoWatt = num2sip(Pr)
```

```
picoWatt =
'4.421 p'
```

```
todBm = 10*log10((Pr*1000)/1) % final answer
```

```
todBm =
```

```
-83.544823691254
```

2.d Solution: The loss from VSWR is defined as:

$$L_{\text{VSWR}} = 1 - \left(\frac{\text{VSWR} - 1}{\text{VSWR} + 1}\right)^2$$

$$P_{\text{in}} = \frac{P_{\text{effective}}}{\eta}$$

Therefor the transmitter the total power is described: $P_{\text{transmitter}} = \dfrac{P_{\text{effective}}}{\eta \cdot L_{\text{VSWR}}}$

```
Lvswr = 1-((1.3-1)/(1.3+1))^2;
eta = 0.7;
Peffective = 2;
Ptransmitter = Peffective/(eta*Lvswr); % for at tillade effektiv 2w skal der bruges
2.9 W istedet.
```

```
Ptransmitter =
          2.90659340659341
```