S-26.3150 Antennas - Practice

May 24, 2012 in hall M at **9:00–12:00**
Maximum points: 6 + 6 + 6 +10 + 10 = 38 p.

Use of literature or own notes is **not** allowed

1. Shortly explain:
   a) gain (2 p.)
   b) omnidirectional antenna (2 p.)
   c) helix antenna (2 p.)

2. Briefly discuss which characteristics of the two antennas used at the ends of a point-to-point radio link can affect the quality/performance of the radio link. (6 p.)

3. Assume you have the 2-D directional antenna pattern cuts at 1 GHz, illustrated in Fig. 1, at hand in numerical format, i.e. the field strength measured in E- and H- planes:

Indicate which of the six antennas shown below could produce a directional pattern as in Fig. 1, and justify your choices!

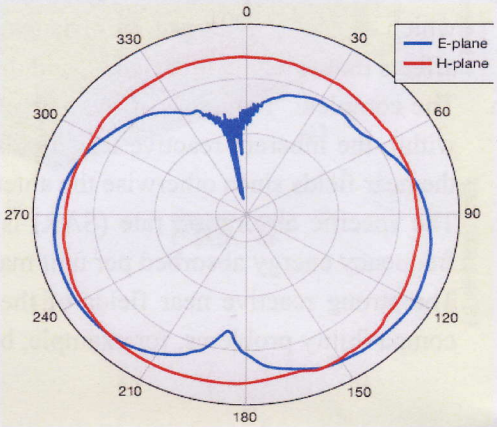
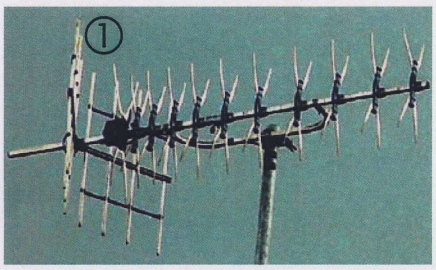
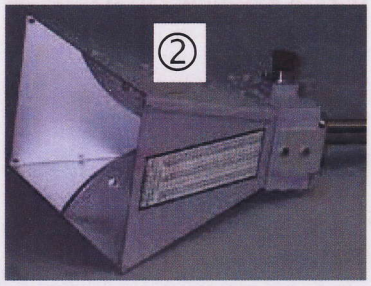
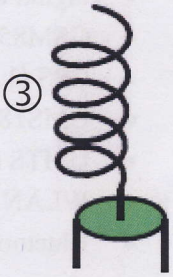


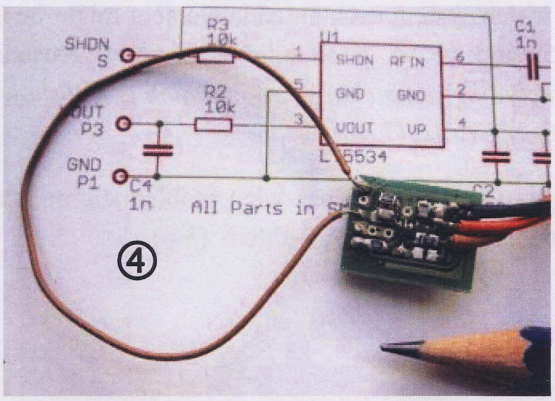
Figure 1: Directional pattern cuts of antenna under test at 1 GHz

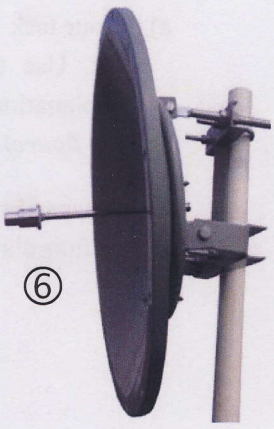
Then, illustrate roughly the radiation patterns (e.g. as typical 2-D cuts) of the other antennas. (6 p.)











4. Each of the following statements (a.-j.) is either "true" or "false" and worth one point. If the statement is "true", answer "TRUE" on your paper. If the statement is "false", write a correction on your paper. If you try to correct a "true" statement, you will lose the point (even though your correction would also be true). The maximum number of points is ten (10).

a. An electrically small antenna is one that can be physically bounded by a sphere having a radius equal to $a = \lambda_0/2\pi$, where λ_0 is the free-space wavelength.
b. The far-field boundary of an **electrically small** antenna can be estimated from expression $2 \cdot d^2/\lambda_0$, in which d is the largest dimension of the antenna perpendicular to the direction of observation.
c. Inherent property of electrically small antennas is the impaired performance compared to essentially larger antennas.
d. Electrically small antennas store much more energy in the reactive near fields than it is radiated into the far field in a time period.
e. The directivity of an electrically small antenna is often close to 2 dBi.
f. The three important characteristics of small antennas (size, bandwidth and efficiency) are interrelated: improvement of one characteristic typically deteriorates the others.
g. It is a well-known fact that lossy dielectric material (such as a user) within the reactive near fields, which typically extends to a distance of $\lambda_0/2\pi$ from the surface of an electrically small antenna, affects the matching, efficiency, and directional pattern of the antenna.
h. The complete "removal" of the user effect phenomenon is very challenging because it takes place within the inherent reactive near fields, and on the other hand it is impossible to totally eliminate the near fields since otherwise the antenna would not radiate.
i. The specific absorption rate (SAR) is used as a measure to determine the time rate of the radio frequency energy absorbed per unit mass of human tissue.
j. The strong reactive near fields of the mobile terminals antennas can also cause electromagnetic compatibility problems, for example, by disturbing the operation of the hearing aid of the user.

5. A figure below shows a mobile terminal chassis on which seven separate antenna elements are mounted. The figure is from the patent "Internal digital TV antennas for handheld telecommunication device" by Jani Ollikainen etc. The antennas for the following systems are present:

- digital television (DVB-H, 0.47 - 0.75 GHz),
- GSM850/900 (0.824 - 0.96 GHz),
- GPS (1.57542 GHz),
- GMS1800/1900 (1.71 - 1.990 GHz),
- UMTS (1.92 - 2.17 GHz),
- WLAN (2.4 - 2.5 GHz), and
- Bluetooth (2.4 - 2.5 GHz).

a) Your task is to define and especially justify for which system each antenna element might be used for. Use the numbers 30, 61, 62, 63, 64, 65, and 66. A good answer provides reasonable explanations. *Hint: the antenna 30 is a CCE (including a matching circuit which is* ***not*** *shown in the figure) and the other antennas are either IFAs or PIFAs.* (7 p)

b) Discuss briefly, why this kind of antenna configuration might be somewhat problematic in today's or future's "smart phones". Propose solutions, how to overcome the problem. (3 p)

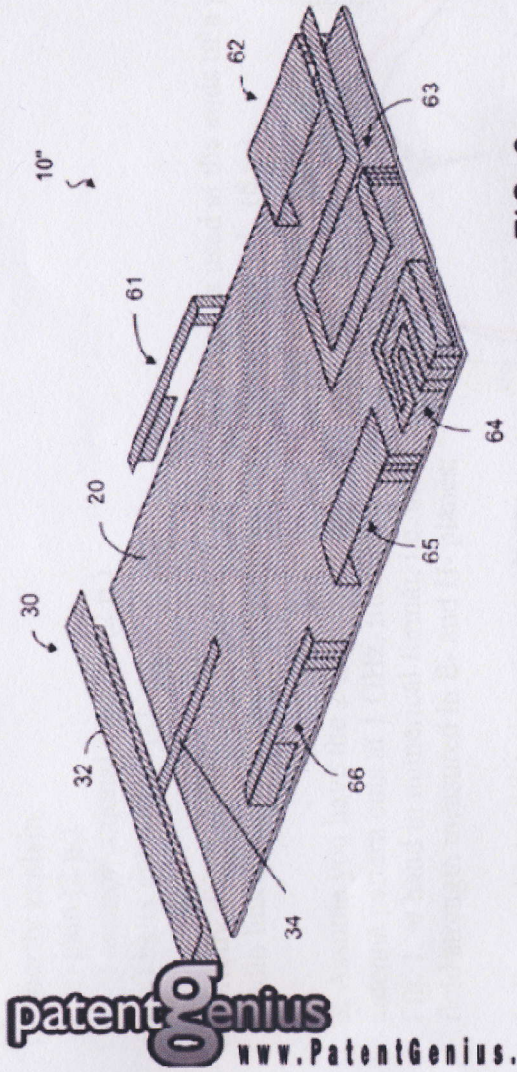


FIG. 9