

# Microwaves

## Series 10,

### Problem 1

We use a one coupler reflectometer to measure the reflection coefficient of a single port device, and we obtain  $|b/b_{cc}| = 0,4$ . We know that the used coupler has a coupled level of 10dB and a directivity of 26dB. Find the unknown reflection coefficient  $\rho$ , the percentage of power reflected by the device and its standing wave ratio (VSWR). Give the error margins for all three entities. (As the coupling level is moderate, give the exact error margins, not the approximated ones)

### Problem 2

We want to realize a hybrid coupler in microstrip technology, similar to the coupler depicted in figure 6.39 of the handouts but with a 10dB power ratio between the direct (attenuated) and the coupled ports. Determine the characteristic impedances of the lines of the coupler, knowing that the impedance of the ports is  $50 \Omega$ .

### Problem 3

Find the scattering matrix of the device formed by a lossless symmetric coupler with  $\alpha=\beta$  (hybrid coupler, scattering matrix given below), where ports 2 and 4 are terminated by identical total reflections. What is this device ?

$$\text{scattering matrix of the coupler : } [S] = \begin{bmatrix} 0 & \alpha & 0 & j\beta \\ \alpha & 0 & j\beta & 0 \\ 0 & j\beta & 0 & \alpha \\ j\beta & 0 & \alpha & 0 \end{bmatrix}$$