CRL 712 RF and Microwave Active Circuits

Major Examination (Time 2 hrs) **8th May 2007**

Note: Solve all questions **Max Marks: 30**

1. Fig.1 shows a SPDT switch employing identical p-i-n diodes. The forward and reverse bias impedances of the diode are, Z_f = 1Ω and Z_r = -j500Ω, respectively. The characteristic impedance of all transmission lines is Z_0 = 50Ω. The lines are assumed to be loss less. The frequency of operation is 3 GHz. 20 mW of power is fed to port 1 and ports 2 and 3 are connected to matched power meters. Port 1 is connected to a generator of internal impedance Z_0
   (a) Calculate the insertion loss of the switch in dB.
   (b) What would be the reading in mW on the power meter at the isolated port?

   Marks (6+6)

2. How do we obtain reciprocal phase shift in a ferrite phase shifter? Explain with the help of a neat diagram.

   OR

   A one-port active device can be modeled as a (negative) resistance of -5 ohm in series with a 1 nH inductor. A parallel R-C load is used. What should be R and C, so that the frequency of oscillation is 10 GHz? Ignore large-signal and stability issues.

   Marks (5)

3. The layout of a series-shunt switched line phase shifter using three identical p-i-n diodes is shown in Fig.2. The shunt diode is connected at the centre of the path of length θ_2. The characteristic impedance of all the transmission lines is Z_0=50 ohms. The path lengths are: $\theta_1 = 60^0, \theta_2 = 240^0$.
   (a) Explain the operation of the phase shifter assuming p-i-n diodes to be ideal.
   (b) Draw the equivalent circuit for the even-and odd-mode analysis for non-ideal diode and derive expression for the transmission coefficient S_{21}.
   (c) If the parameters of the p-i-n diode are: Z_f=2 ohms under forward bias and Z_r=∞ under reverse bias; what is the phase shift error.

   Marks (2+7+4)

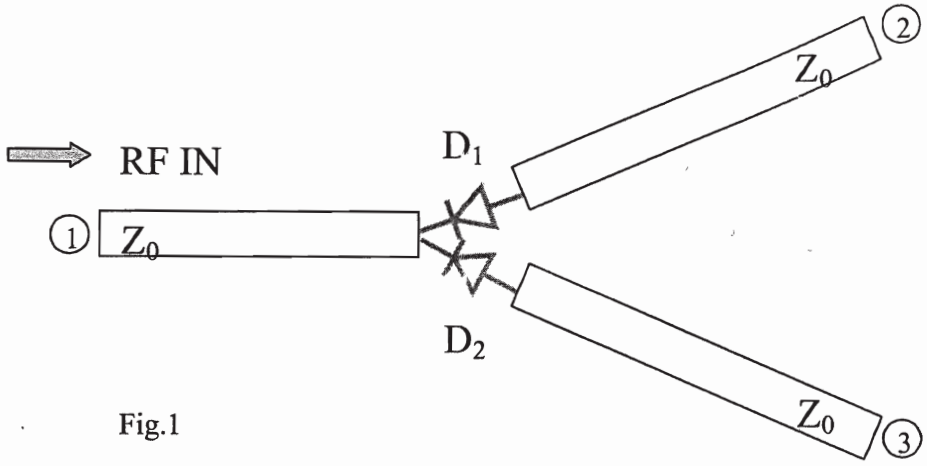


Fig.1

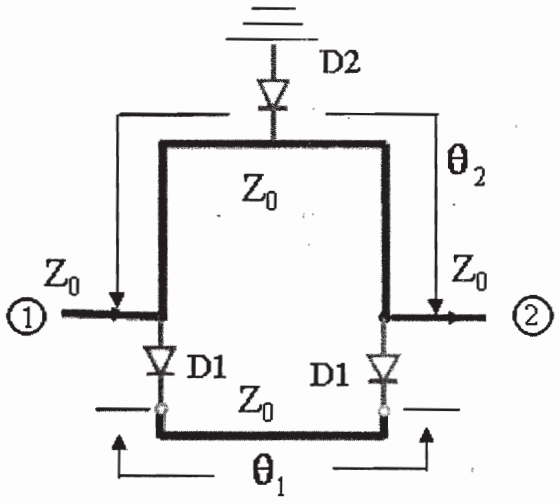
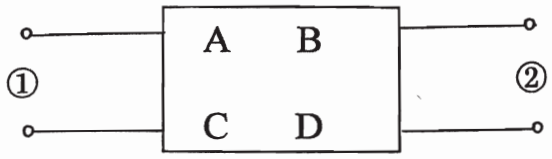


Fig.2



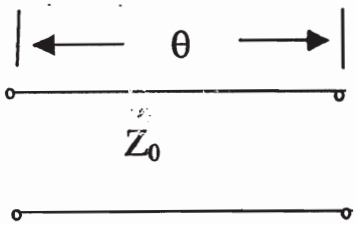
$$S_{11} = \frac{A + BY_0 - CZ_0 - D}{\Delta}; \quad S_{22} = \frac{-A + BY_0 - CZ_0 + D}{\Delta};$$

$$S_{12} = \frac{2(AD - BC)}{\Delta}; \qquad S_{21} = \frac{2}{\Delta}$$

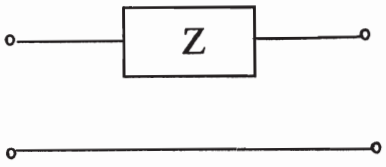
where $\Delta = A + BY_0 + CZ_0 + D$

Network

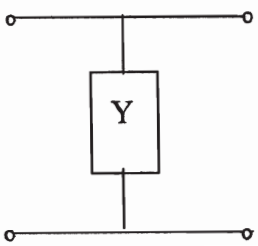
$$\begin{bmatrix} A & B \\ C & D \end{bmatrix}$$



$$\begin{bmatrix} \cos\theta & j Z_0 \sin\theta \\ j Y_0 \sin\theta & \cos\theta \end{bmatrix}$$



$$\begin{bmatrix} 1 & Z \\ 0 & 1 \end{bmatrix}$$



$$\begin{bmatrix} 1 & 0 \\ Y & 1 \end{bmatrix}$$