Indian Institute of Engineering Science and Technology, Shibpur

ME (ETC), 2nd Semester, Final Examination, 2014

Advanced Microwave Circuits, Systems and Measurements (ETC-1033)

Time: 3 hours Full marks: 70

Answer any FIVE questions. Questions are equal valued.

1. (a) Describe the low-frequency characteristics of microstrip line. (b)Draw the electrical field distribution of a coupled microstrip lines and describes their parallel plate and fringing capacitances. (c) What do you understand by even mode and odd mode propagation? Find out the expression for characteristic impedance and effective dielectric constant for both the modes of excitation. (d) What is edge coupling and broadside coupling-explain with suitable diagram?

2. (a) What are Immittance Inverters? Write down the *ABCD* matrix representation of ideal impedance inverters. (b) How are immittance inverters used to convert a shunt capacitance into an equivalent circuit with series inductance and vice versa? (c) Realize generalized bandpass filters using immittance inverters. (d) How do you realize immittance inverters in microstrip circuit.

3. (a) Write down the n^{th} order Chebyshev function in term of normalized frequency. Hence drive the Chebyshev lowpass approximate filter function. (b) Draw and explain the lowpass prototype ladder network and its dual for all-pole filters. (c) Write down the design steps of 5^{th} order parallel coupled half-wavelength bandpass filter (d) Discuss the concept of designing Hairpin-line type Bandpass Filter.

4. (a) Describe four port symmetrical S-parameter network representation of a uniformly coupled lines for even mode and odd mode excitation. (b) Hence derive S-parameters for Forward wave Directional Coupler. (c) Write down the design procedure of a Backward wave Coupler for uniformly coupled lines.

5. (a) What is Branch line coupler? Design a 3dB Branch line coupler with port impedance of 50Ω. Why 3dB Branch line coupler is called 90 degree hybrid? How VSWR, coupling coefficient and isolation vary with normalized frequency. (b) Modify the design of the branch line coupler using Shorted coupled-line pair for loose coupling. (c) Design reduced-size branch-line hybrids using lumped capacitors and small sections of transmission lines.

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6. (a) Design and analysis of a Rat-Race coupler in microstrip form. Explain its special properties and applications. What happen, if a coupled line section replaces $3\lambda g/4$ line of a Rat-Race coupler? (b) How a lump element Rat-Race coupler is designed?

7. (a) Define coupling, directivity and isolation of a Parallel-Coupled directional couplers. Define power loss ratio of a directional coupler. (b) A directional coupler of 10 ± 0.5-dB coupling is desired in the configuration as shown in Figure 1 at a frequency of 10 GHz. Determine the physical dimensions of the coupler assuming that ports are terminated in 50 Ohm impedance and the coupler is realized in a strip line of a substrate dielectric constant = 2.25.

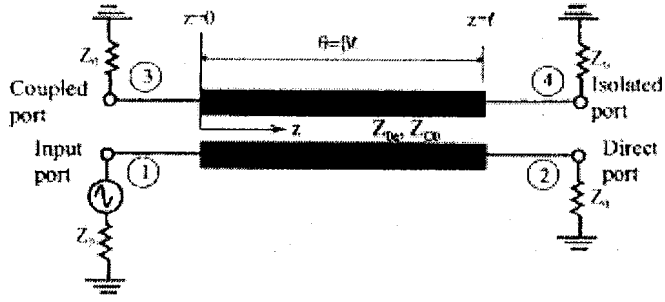

Figure-1

Calculate even mode and odd mode characteristics impedance and guided wavelength of the coupler. Hence calculate s/h and w/h ratios. (c) How is a Multisection Directional Couplers designed? Discuss the advantages and limitations of such coupler.

8. Write short note (any TWO) on followings:

(a) Broadband microwave biasing circuit using coupled lines and shunt stubs
(b) Microstrip baluns using coupled gap line.
(c) Chip capacitor and resistor
(d) Biological effect of Cell Tower radiation