## EE6311 Design Project #4 – Attenuators

Note: Design each network on paper first and then use MWO or ADS to tune and analyze. You can use the ideal SPDT switch in the AWR Element Library (General->Passive->Other->SPDT). Submit your final circuit schematic which includes MSTEP and TEE junction models and plots for each design. Put all plots for each design on the same graph when possible.

Given: $f_o$ = 15 GHz (plot performance over 12-18 GHz frequency range)
substrate $\varepsilon_r$ = 12.9 (GaAs)
substrate thickness, h = 0.10 mm (100 μm)
conductor thickness = 4 μm
conductor metal = Au (use default value for rho in MWO/ADS)

1. Design a microstrip Pi attenuator using ideal (discrete) resistors to achieve a constant 6-dB attenuation with Zin = Zout = 50 Ω. Calculate the S-parameters of the 6 dB attenuator circuit. Plot:
a) S11 mag in dB
b) S21 mag in dB

2. Design the same microstrip Pi attenuator to achieve a constant 6-dB attenuation now with thin-film resistors (TFR Closed Form Model in AWR). For small resistor values, use a resistivity of 2 ohms/per square. For large resistor values, use a resistivity of 50 ohms/per square. (assume F=0 in the TFR parameter block)
Plot:
a) S11 mag in dB
b) S21 mag in dB

3. Design a microstrip Tee attenuator using ideal resistors to achieve a constant 10-dB attenuation with Zin = Zout = 100 Ω.
Plot:
a) S11 mag in dB
b) S21 mag in dB

4. Design a microstrip PIN-diode variable step attenuator. The network must be capable of providing discrete attenuation steps of 3dB, 6dB and 10dB by simply turning PIN diodes on or off. Characteristic impedance is 50 Ω.
Plot:
a) S11 mag in dB of each attenuation state
b) S21 mag in dB of each attenuation state

Due: Monday, November 10, 2008