[A] A Si-Ge heterojunction bipolar transistor is used in an amplifier circuit at 2GHz. The equivalent circuit of the input base for a grounded emitter configuration is estimated to have an input resistance of $5\,\Omega$ in parallel with a capacitance of $1\,\text{pF}$. Design a single stub matching circuit to a $50\,\Omega$ line. Use a Smith chart to design your matching circuit. Determine:

1. The $50\,\Omega$ line length to shunt stub from the load. (1 point)
2. Determine the length of the $50\,\Omega$ open circuit stub (1 point).
[B] A coaxial line operates at 2 GHz and is designed to have an impedance of 50Ω. Assume that the coaxial line is filled with dielectric material whose relative permittivity $\epsilon_r$ is 2.25, has an inner copper conductor diameter is 2mm.

1. Derive the expression for capacitance per unit length using Gauss’s Law. (0.5 points)
2. Derive the expression for the inductance using Ampere’s Law. (0.5 points)
3. What is inner diameter of the outer conductor to ensure the impedance is 50Ω. (0.5 points)
4. What is the phase velocity of this coaxial line? (0.5 points)