Assume that the short interest rate follows Black-Derman-Toy model

$$d\log(r_t) = \theta(t)dt + \sigma dW_t$$

where $\theta(t)$ is a deterministic function of time, σ is constant parameter, and W is a standard Brownian motion.

In your report, please address the following questions

1. Provide valuation formulas for risk-free zero-coupon bonds.
2. Use the data for current U.S. Treasury yield curve, to calibrate $\theta(t), \alpha, \sigma$.
3. Develop an algorithm based on Monte-Carlo method that prices European swaptions. Provide numerical examples using parameters from calibration above.