A step-by-step checklist to calculate V_T of a MOS

	Value
1) What is the gate material ? Find value of ϕ_M	
2) What is the doping type of substrate? What is the doping concentration N? Calculate $|\phi_F| = kT/q \bullet \ln (N/n_i)$ Calculate ϕ_S : For p-substrate $\phi_S = \chi + E_g/2 + |\phi_F|$ For n-substrate $\phi_S = \chi + E_g/2 - |\phi_F|$	
3) Calculate $\phi_{MS} = \phi_M - \phi_S$	
4) What is the gate oxide thickness ? Calculate C_{ox}	
5) Is there any reverse bias between channel and substrate ? If yes , calculate $|V_C - V_B|$. If not, set $|V_C - V_B| = 0$	
6) Calculate V_{Si} at onset of strong inversion $V_{Si} = 2|\phi_F| + |V_C - V_B|$	
7) Calculate x_{dmax} $x_{dmax} = \sqrt{\dfrac{2\varepsilon_s V_{Si}}{qN}}$	
8) Calculate V_{ox} $V_{ox} = \dfrac{qN x_{dmax}}{C_{ox}}$	
9) Is there any threshold implant ? What is the implant dopant type? For p-type implant , ΔV_T (threshold implant) $= + Q_i /C_{ox}$ For n-type implant , ΔV_T (threshold implant) $= -Q_i /C_{ox}$	
10) Is there any oxide charge $\rho_{ox}(x)$ or interface charge Q_f ? If yes, ΔV_T (oxide charge) $= -\dfrac{Q_f}{C_{ox}} - \displaystyle\int_{0}^{x_{ox}} \dfrac{x\, \rho_{ox}(x)\, dx}{\varepsilon_{ox}}$	
11) For p-substrate (NMOS) $V_T - V_B = \phi_{MS} + V_{ox} + V_{Si} + \Delta V_T$ (threshold implant) $+ \Delta V_T$ (oxide charge) For n-substrate (PMOS) $V_T - V_B = \phi_{MS} - V_{ox} - V_{Si} + \Delta V_T$ (threshold implant) $+ \Delta V_T$ (oxide charge) Note: If substrate is grounded, $V_B = 0$	