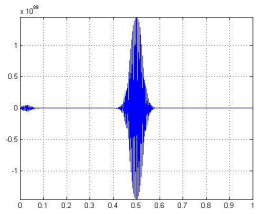
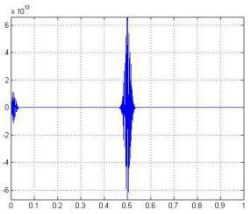
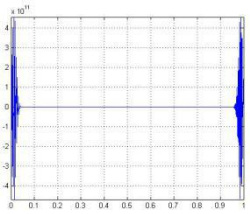
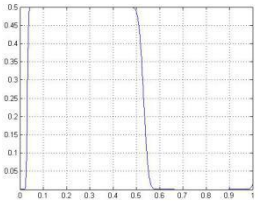
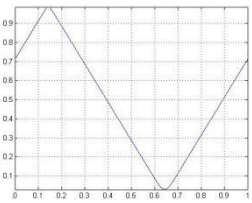
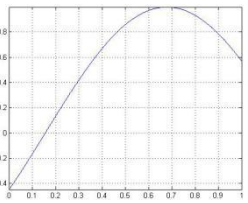
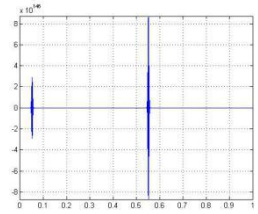
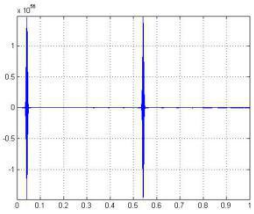
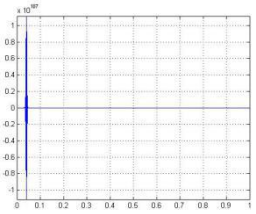
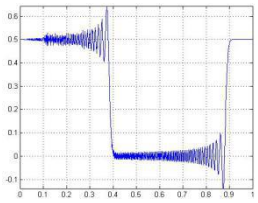
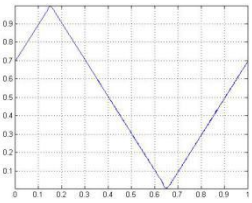
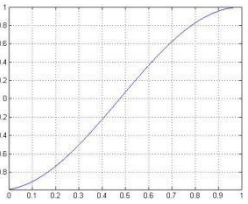
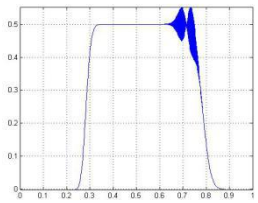
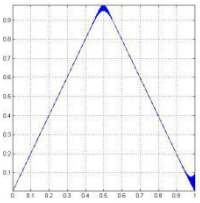
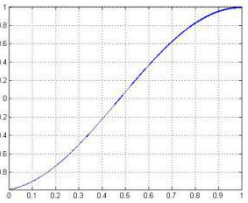
A short note: For Question 1

Both Method are good with Consistency.

The FSCT has truncation error $O(h_t, h_x^2)$, so when $h_t \to 0$, $h_x \to 0$, error goes to 0.

The C-N has truncation error $O(h_t^2, h_x^2)$, so when $h_t \to 0$, $h_x \to 0$, error goes to 0.

Problem 2 Sum_up Sheng Xu

	Discontinuous	C^0	C^∞
FSCT	Unstable 	Unstable 	Unstable 
1st Upwind CFL	Stable with dissipation 	Stable with dissipation 	Stable 
1st Upwind non-CFL	Unstable 	Unstable 	Unstable 
Crank-Nicholson	Stable with Dispersion 	Stable with dissipation 	Stable 
BSCT	Stable with Dispersion 	Stable with Dispersion 	Stable 

Functions	Discontinuous	C^0	C^∞
	F=0 when -1≤ x <-0.5 0≤ x < 0.5 F=0.5 when -0.5≤ x < 0 0.5≤x<1	F=2x+2 when x≤ -0.5 F=-2x when -0.5≤x<0 F=2x when 0≤x<0.5 F=2-2x when 0.5≤ x≤1	cos(3x)

Conclusion:

All stable methods exhibit certain dissipation with C^{∞} functions. FSCT and First Order Upwind method without CFL are never stable.

For Discontinuity and C^1 functions, both implicit methods(C-N and BSCT) exhibits dispersion, making pictures less smooth. BSCT is more effected in C^1 function, while C-N is more effected in Discontinuity function.