

1)

$$V_T(S, T) = \begin{cases} 50 - S_T & \text{if } S_T < 30 \\ (50 - S_T) + 2(S_T - 30) = S_T - 10 & \text{if } 30 \leq S_T \leq 50 \\ 2(S_T - 30) & \text{if } 50 < S_T \end{cases}$$

$$T - t = 0.5 \quad \sigma = 0.2 \quad S = 30 \quad r = 0.05$$

$$V_0(30, 0) = 2C(30, 0) + P(30, 0)$$

$$= 2 \left(30 \Phi \left(\frac{\ln(30/30) + (0.05 + \frac{0.2^2}{2})(0.5)}{0.2\sqrt{0.5}} \right) \right)$$

$$- 30 e^{-0.05(0.5)} \Phi \left(\frac{\ln(30/30) + (0.05 - \frac{0.2^2}{2})(0.5)}{0.2\sqrt{0.5}} \right)$$

$$+ 50 e^{-0.05(0.5)} \Phi \left(\frac{-\ln(30/50) - (0.05 - \frac{0.2^2}{2})(0.5)}{0.2\sqrt{0.5}} \right)$$

$$- 30 \Phi \left(\frac{-\ln(30/50) - (0.05 + \frac{0.2^2}{2})(0.5)}{0.2\sqrt{0.5}} \right)$$

$$= 60 \Phi(0.2475) - 60 e^{-0.025} \Phi(0.1061) + 50 e^{-0.025} \Phi(3.506)$$

$$- 30 \Phi(3.3646)$$

$$= \$22.90$$

$$2) \quad \sigma = 0.2 \quad r = 0.03$$

$$u = e^{0.2\sqrt{0.25}} = 1.105$$

$$d = \frac{1}{1.105} = 0.905$$

$$q = \frac{R - d}{u - d} = \frac{(1 + \frac{0.03}{4}) - 0.905}{1.105 - 0.905} = 0.512$$