Foundations of Finance, Fall, 2008
Prof. Joel Hasbrouck
Problem set 4 W DUE IN CLASS WEDNESDAY, DECEMBER 10

Although you may discuss these problems with others, you should calculate everything yourself (just to make sure that you can get your calculator to give the same answers that everyone else is getting). Your solutions must be written up by yourself: you must turn in the original. If you won't be in class on the day the problem set is due, you can fax me a pdf, and turn in the original at the next meeting.

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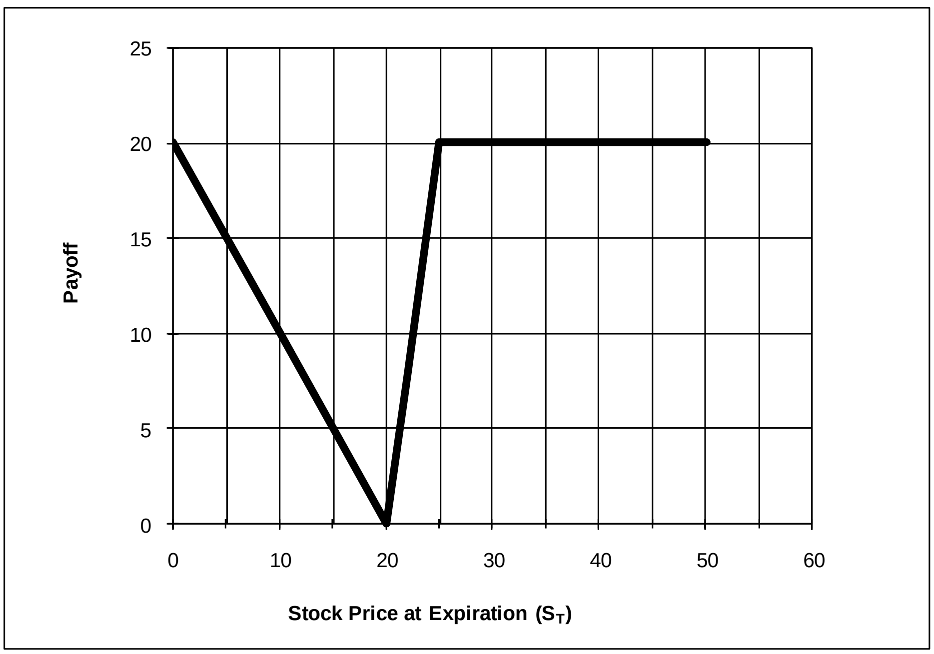
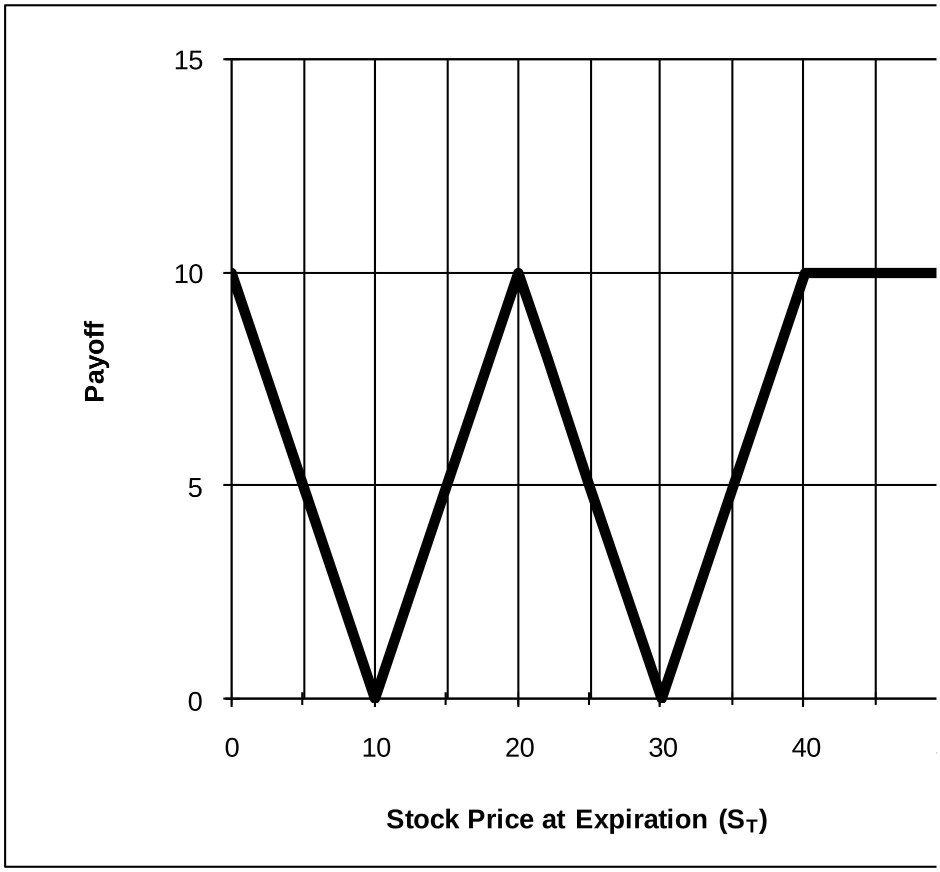
1. Graph the payoff to a portfolio consisting of:
   a. Long 4 calls with X=20
   b. Short 4 calls with X=25
   c. Long one put with X=20

Answer:



2. The payoff function of an “W-for-Wednesday” strategy is



How would you form a portfolio that will give this payoff. You can use whatever combination of puts, calls, bonds or underlying you wish, and anything can be held long or short. (Hint: you can generate this payoff function using only puts and calls. Try working from left to right.)

Answer:

Security	X	Amt
Call: X=	10	1
Call: X=	20	-2
Call: X=	30	2
Call: X=	40	-1
Put: X=	10	1

3. WCL stock is currently trading at 35; and it has a volatility of σ=0.25. Consider a call option with X=30 and T=2 years. The risk-free rate is 7% (continuously compounded annual rate).
   a. According to the Black-Scholes formula, what is the value of the call option? (In addition to C, show the following intermediate quantities: d_1, d_2, $N(d_1)$, $N(d_2)$)
   b. If the equities desk at a bank has just written this call (size=10,000 shares), how many shares should they be long or short to be hedged?
   c. Using put-call parity, what should be the price of a European put option with X=30 and T=2?

Black-Scholes: Details of calculations

Inputs:	
S	35.00
X	30.00
r	0.07
Volatility, s	0.25
T	2.00
Calculations:	
ln(S/X) = ln(35.00/30.00)	0.1542
s sqrt(T)=35 x sqrt(2.00)	0.3536
(r + s*s/2)*T = (0.07 + 0.25*0.25/2)*2.00	0.2025
d1 = [ln(S/X) + (r + s*s/2)*T]/(s sqrt(T)	1.0088
$N(d_1)$	0.8435
d2 = d1 - s x sqrt(T) = 1.009 - 0.354	0.6552
$N(d_2)$	0.7438
S x N(d1) = 35.00 x 0.8435	29.5209
Exp(-rT) = Exp(-0.07 x 2.00)	0.8694
Bond = X Exp(-rT) = 30.00 x 0.8694	26.0807
Bond x N(d2)	19.3997
Call = S N(d1) - Bond N(d2) = 35.00 x 0.8435 - 26.0807 x 0.7438	10.1212
Put = Bond + Call - S = 26.0807 + 10.1212 - 35.00	1.2020

The hedge ratio for the call is 0.8435, so the bank should be long 8,435 shares of stock.