Homework 11– Assigned: April 1, 2026, Due: April 8, 2026

1. Competitive Bidding Analysis – Opponents not identified by name.

The table below shows the costs estimated by a contractor for the past 30 projects and the bid prices submitted by his opponents. (The table does not show the contractor's own bid price. Also, each of the columns B_i does not show the bid prices of any particular opponent.)

Find the optimum Markup% (= x_0-1 = *FBC*-1) that this contractor should use for bidding on the next job. Use the following methods described in your notes:

a. Method I - Brute Force (a) $E[V|FBC]$ is in $ (uses costs of past jobs that would have been won).
b. Method I - Brute Force (b) $E[V|FBC]$ is in % (uses the fraction of past jobs that would be won).
c. Method II - *LBC* follows a Normal distribution.
d. Method III - Using Friedman's formula, for number of competitors, n = 1, 3, and 7.
e. Method III - Using Gates' formula, for number of competitors, n = 1, 3, and 7.

Show "$P[Win|FBC]$ vs Markup%" in two graphs, (A) & (B). Graph (A) shows the two curves for methods (b) and (c) and graph (B) shows the six curves for methods (d) and (e). Compare these curves.
Show "$E[V|FBC]$ vs Markup%" in two graphs, (C) & (D) where graph (C) shows the three curves for methods (a), (b), (c), and graph (D) shows the six curves for methods (d) and (e). Compare these curves.

Project	Est. Cost	Opponents' Bids ($1,000)						
No.	($1,000)	B1	B2	B3	B4	B5	B6	B7
1	96.90	103.10	102.47					
2	555.06	584.76	583.00	575.08	577.94	586.96		
3	244.36	264.09	256.49					
4	988.52	1,043.98	1,034.26	1,041.55	1,053.69	1,089.32	1,088.51	
5	718.80	760.55	755.44	796.62				
6	308.28	348.86	327.42					
7	201.25	203.19	208.69	205.20				
8	481.50	484.05	488.08	505.08	491.55	488.09		
9	413.11	447.48	438.29	410.10				
10	293.83	318.42	313.43	304.15	304.38	315.17	311.00	
11	1,065.74	1,233.36	1,095.98	1,125.79	1,106.78	1,145.66	1,158.19	1,098.14
12	932.40	976.85	922.25					
13	466.62	488.52	490.36					
14	1,219.19	1,247.89	1,209.79	1,322.60	1,209.29			
15	254.43	274.48	266.46	261.32	256.49	264.81	258.64	
16	193.17	207.90	209.48	200.14	200.22	207.27		
17	767.21	822.12	856.44	841.46				
18	107.88	120.33						
19	499.80	517.44	528.02	545.66	522.93			
20	645.42	743.37	748.02	722.85	746.11	757.05	684.55	673.60
21	887.86	911.60	872.73	948.75				
22	615.49	680.39						
23	520.13	605.88	538.92	558.58	600.05	600.11	559.87	
24	200.78	211.21	207.76	209.96	215.91	205.56	199.29	
25	854.25	894.20	888.02	974.47	930.52	948.32	985.72	877.85
26	444.75	469.06	476.93	497.40	496.12	463.76	465.41	456.09
27	650.28	676.75	657.36	700.33	714.47	719.19	685.65	
28	954.91	965.10	1,004.30					
29	900.62	895.40	881.48	971.27	912.46	928.46	958.39	940.30
30	834.52	920.71	919.70	897.39	900.09	890.63	890.74	

2. Competitive Bidding Analysis – Statistical data for specific opponents are available.

Reynolds Construction has compiled the following information about the bidding behavior of their competitors over the past couple of years. (BC = bid-to-cost ratio, m = mean, σ = standard deviation.)

Competitor	m_{BC}	σ_{BC}
Ajax Co.	1.04	0.02
Baker Constr.	1.06	0.04
Carter, Inc.	1.02	0.02
All Others	1.06	0.03

On a job coming up, Reynolds expects to be bidding against four opponents:
Ajax, Baker, and 2 other competitors (use the row "All Others" for each of these two).

Assume that all distributions are Normal.

Find the optimum Markup% (= x_0-1 = FBC-1) that Reynolds should use on the next job to maximize expected profit according to

(a) Friedman
(b) Gates

Prepare one graph that shows both $E[V|FBC]$ curves (one for Friedman and one for Gates) as functions of Markup% (= x_0-1 = FBC-1) to allow comparison.
(NOTE: In the same graph you will also show the two curves for the problem below.)

3. Competitive Bidding Analysis – Carter may or may not bid the job.

Before submitting his bid, Reynolds receives new information and now believes that there is a 50% chance that Carter might also bid the job considered in the problem above.

Draw the decision tree for this problem and label the nodes and branches appropriately. (*)

What is Reynolds optimal markup now according to:

(a) Friedman
(b) Gates

Plot the two $E[V|FBC]$ curves as functions of Markup% (= x_0-1 = FBC-1) in the same graph with the two curves from the problem above. Compare the four curves in this one graph.

(*) Note: The decision tree for this classic decision analysis problem is like the one shown on the first page of your class notes on bidding models. First, Reynolds must choose his Markup% (= x_0-1 = FBC-1) and prepare and submit a sealed bid. Afterwards, at bid opening (*i.e.*, after all bids have been submitted) Reynolds will find out whether Carter has bid the job or not. Finally, a chance node follows where Reynolds wins (or loses) the job, with a probability that depends on how many opponents (four or five) have bid the job for that branch of the decision tree.