Student Name: _____

EBGN 645: Homework 1, Part A – Due: 10/6/2025

All code needs to accompany the homework submission

Label code for each question Qx.gms where x=1,2

Store all everything in a "HW1" subdirectory in your GitHub repository

There should only be one file/model for each question – counterfactuals should be enabled via switches

Note: These are intended to be simple problems to help make sure the basics of GAMS and linear programs are well understood before we move into more complicated topics. If Q1, Q2a, or Q2b are overly difficult or hard for you, please see me immediately.

Q2c and Q2d are intended to make you think creatively and to practice problem-solving – we will cover similar problems in class.

Q1 (25 points): Benny's bakery
Benny makes rolls, croissants, and bread loafs. The price, cost, and time for each is in the table below. Benny only has 40 hours to work in a week.

Product	Revenue ($/item)	Cost ($/item)	Time (hours/item)
Roll	2.25	1.5	1.5
Croissant	5.5	2	2.25
Bread	10	5	5

a. (5 points) Write out the indices, parameters, variables, objective function, and constraints for this problem. Make sure to indicate units on your parameters and variables.

b. (5 points) Counterfactual: Benny now requires a roll to be sold with every croissant. Rolls can still be sold individually. Write out the math for this constraint.

c. (15 points) Write the problem in GAMS solving the reference and counterfactual case. Be sure to use a switch to enable the counterfactual. Report on the optimal values of production in both the reference and counterfactual scenarios, including total profits.

Q2 (50 points): June's Jellybeans

June has a jellybean factory with two machines, X1 and X2, that produce yellow, blue, green, orange, and purple jellybeans. The net revenue for each type of jellybean are in the table below. Assume each machine can produce 100 jelly beans per hour and can only run 40 hours per week.

Color	Yellow	Blue	Green	Orange	Purple
Net Revenue ($/bean)	1	1.05	1.07	0.95	0.9

a. (5 points) Write out the indices, parameters, variables, objective function, and constraints for this problem. Make sure to indicate units on your parameters and variables.

b. (15 points) Write the model in GAMS. What is June's profit-maximizing production profile?

c. (15 points) Now, June must produce jellybeans in nearly equal amounts. For all jellybean colors, there can only be 5% deviation across all production amounts relative to other colors. For example, if June produces 100 green jellybeans, she has to produce between 95 and 105 orange jellybeans. If she produces 105 orange jellybeans, she has to produce between (0.95 * 105 =) 99.75 and (1.05 * 105 =) 110.25 yellow jellybeans.

   How does her production profile change? What impact does this have on profits?

   Hint: this requires an alias – as an example…

   ```
   set b "beans" /yellow, blue, green, orange, purple/ ;
   alias(b,bb) ;
   equation eq_prodlimit_upper(b,bb), eq_prodlimit_lower(b,bb) ;
   …
   ```

d. (15 points) Now, in addition to part *b*, the first machine only produces yellow, blue, and green jellybeans. The second machine only produces yellow, orange, and purple jellybeans.

   How does June's production profile and profits change with this restriction?

Hint: Use a conditional set to limit the production from each machine based on these combinations; this will need to be included anywhere the production variable, Q(m,b) in the example below, is included. As an example…

set m "machines" /X1, X2/ ;
set b "beans" /yellow, orange, red/ ;
set m_b(m,b) "valid combinations of m and b" ;

m_b("X1","yellow") = yes ;
…
m_b("X2","yellow") = yes ;

*sum((m,b)$m_b(m,b), revenue(b) * Q(m,b)) ;*