Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Exam 1 ISyE 4301**

***Please read the following***: This is a closed-book and closed-note exam. In addition, you are only allowed to use calculators that are not “connected”, e.g., no smart phones. By signing the following, you are agreeing to these terms and acknowledging that all of the work on this exam is your own.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(*Signature*)

*The following multiple-choice questions are worth 5 points each. Clearly mark your answer.*

1. A store has a single customer that orders on average 10 items per week. Half of the time the customer orders 0 and half of the time they order 20 (but the store cannot predict which). The store replenishes every 3 weeks, and replenishment leadtime is zero. The store maintains a 100% service level. How much average inventory (pipleline plus cycle plus safety) does the store hold?
2. Average inventory is 25
3. Average inventory is 45
4. Average inventory is 50
5. Average inventory is 60
6. None of the above
7. A store uses an (*R*,*Q*) policy with an order quantity of 100. The annual demand faced by the store is normally distributed with a mean of 5200 and standard deviation of 700. The replenishment leadtime is 1 week. If they desire a service level of 95%, what should the value of *R* be?
   1. R=100 + 700/12\*1.645
   2. R=5200\*sqrt(1/52)+700\*sqrt(1/52)\*1.645
   3. R=100+ 700\*sqrt(1/52)\*0.3289
   4. R=100+ 700\*sqrt(1/52)\*1.645
   5. None of the above
8. A firm uses two inputs (Y1 and Y2) to produce units of output (Q). Suppose we triple the inputs and the output goes up by a factor of 2.8 times. Which is the best answer?
   1. The firm is showing decreasing returns to scale
   2. The firm is showing increasing returns to scale
   3. The marginal rate of technical substitution (Y1 for Y2) is 2.8
   4. a. and c. are both true
   5. b. and c. are both true
   6. None of the above
9. Suppose the percent change in quantity demanded decreases by 1% when the percent change in price increases by 3%. Which of the following is true?
   1. Demand is inelastic
   2. Demand is elastic
   3. Demand is inelastic
   4. We don’t have enough information to determine

*The two following concept questions are worth 10 points each. Please make your answers are clear and concise.*

1. In class we discussed a firm’s expansion path (i.e., how a firm’s output changes with total costs (budget). Do the following:
   1. For two inputs *K* and *L* (with unit costs wK and wL), write the firm’s optimization problem to achieve a given output *Q*0

* 1. Show graphically two points on the expansion path. Make sure and label everything clearly.

1. A firm currently sells two items A and B; demand for each is normally distributed with the same mean and variance. They are considering a universal design. They use a (*R*,*Q*) system to manage inventory.
   1. Explain the potential benefit that would be achieved from this design and how it would be achieved. Estimate the amount of savings (use general expression).
   2. Suppose demands for A and B is negatively correlated. What would the impact be?
   3. What factors other than those mentioned in a. and b. should be considered if going to a universal design?
2. (20 points) Consider the flight network shown below. Capacity on each leg is 100. There are 7 possible tickets, with origin-destination (price; expected demand) 1. A-B ($150;30), 2. A-B ($100;80), 3. A-C ($400;30), 4. A-C ($300;40), 5. A-C ($200;50), 6. B-C ($200;30), and 7. B-C ($150;45).  
     
     
     
   1. Write the primal and dual formulations. Explain in words what the dual variables represent.

* 1. Suppose you find that the bid price for A-B is $150 and for B-C is $170. Which tickets should not be offered?
  2. Rewrite the dual formulation assuming we sold 5 tickets of A-C ($200;50).

1. (**NOTE: We have not covered this material yet**) (20 points) A manufacturer produces flu vaccines for the flu season that they sell through CVS (assume newskid applies). It costs the producer $10 per unit and they sell to CVS at an intermediate price of $30 per unit. Demand for vaccines is normally distributed. CVS sells the vaccine through their stores at $40 per unit. Any units left over are salvaged at $5 each.
   1. Explain why if CVS orders the vaccines based on their analysis that it would lead to decreased profits for the entire supply chain (provide as much detail as you can to make the argument).
   2. How could a buy-back contract be set up to improve profitability for both the manufacturer and CVS as compared to a? Explain how to determine the components of the contract.
2. (15 points) A concert venue faces two types of demand. Demand 1 is given by Q1=100-P1 and demand 2 is given by Q2=120-2P2. The marginal cost of a unit is $10. The firm can segment the market (e.g., checking the age of the person on their driver’s license). In addition, the capacity of the venue is C. Write out the firm’s optimization problem to determine the best prices to charge.