

*MAJU*  
**Department of Computer Science**  
**CS2420: Operations Research**  
**Semester Spring 2022**

**Dated: 8<sup>th</sup> March 2022**

**Due Date: 22<sup>nd</sup> March 2022 (In Class)**

**No late submissions allowed for this assignment**

**Home Work #2**

**Total Points 40 Points**

**NOTES:**

- Please submit fair work, no rough work will be graded.

**FORMULATIONS (10 points each)**

1. The demand for an item over the next four quarters is 400, 250, 300 and 450 units, respectively. The price per unit starts at \$30 in the first quarter and increases by \$2.50 each quarter thereafter. The supplier can provide no more than 350 units in any one quarter. Although, we can order more in early quarters and store them, however a cost of \$5.80 is incurred per unit per quarter and you cannot store more than 80 units in any one quarter. Determine the model that constructs optimum schedule to purchase the item to meet the demand with minimal cost.
2. Each day, workers at the Gotham City Police Department work two 6-hour shifts chosen from 12 A.M. to 6 A.M., 6 A.M. to 12 P.M., 12 P.M. to 6 P.M., and 6 P.M. to 12 A.M. The following number of workers is needed during each shift. Workers whose two shifts are consecutive are paid \$12 per hour; workers whose shifts are not consecutive are paid \$18 per hour. Formulate an LP that can be used to minimize the cost of meeting the daily workforce demands of the Gotham City Police Department. (HINT: Think of all possible combinations of shifts).

Shifts	Required workers
12 A.M. to 6 A.M.	12 workers
6 A.M. to 12 P.M.	6 workers
12 P.M. to 6 P.M.	15 workers
6 P.M. to 12 A.M.	4 workers

3. The city of Hafr-Al Batin is in process of approving a construction site for a new 220,000ft<sup>2</sup> stadium. Two sites have been proposed. The table provides data about proposed (contiguous) properties in both sites together with the acquisition cost.

	Site 1		Site 2	
Property	Area (1000ft <sup>2</sup> )	Cost (\$1000)	Area (1000ft <sup>2</sup> )	Cost (\$1000)
1	20	1000	80	2800
2	60	21000	70	1900
3	50	2350	50	2800
4	30	1850	60	2500
5	50	2950		

Partial acquisition is possible. At least 80% of property 4 must be acquired if site1 is selected, and at least 60% of property 3 is acquired if site 2 is selected. Although site 1 property is more expensive, the construction cost is less than site 2 because of better existing infrastructure at site 1. Construction cost at site 1 is \$30 million and at site 2 is \$32 million. Determine LP model(s) to decide which site is

cheaper for constructing the new stadium. (HINT: Only after you spend one week and cannot figure, consult me).

4. A refinery manufactures two grades of jet fuel, J1 and J2, by blending four types of gasoline, A, B, C, and D. Fuel J1 uses gasolines A, B, C and D in ratio of 1:1:2:4 and Fuel J2 uses gasolines A, B, C and D in ratio of 1:2:1:3. The supply limits for A, B, C, and D are 1200, 1000, 900 and 1500 bbl/day, respectively. The cost per bbl for gasolines for A, B, C, and D are \$100, \$90, \$120 and \$150, respectively. Fuels J1 and J2 sell for \$300 and \$250 per bbl, respectively and minimum demand for Fuel J1 and J2 is 250 and 350 bbl/day, respectively. Develop a LP model to determine the optimum production mix for J1 and J2 fuels.
5. (Optional) In anticipation of the immense college expenses, Mike and Judy started an annual investment program on their child's eighth birthday that will last until the eighteenth birthday. They plan to invest the following amounts at the beginning of each year:

Year	1	2	3	4	5	6	7	8	9	10
Amount	2000	2000	2500	2500	3000	3500	3500	4000	4000	5000

To avoid unpleasant surprises, they want to invest the money safely in the following options: Insured savings with 7.5% annual yield, 6-year government bonds that yield 7.9% and have a current market price equal to 98% of face value, and 9-year municipal bonds yielding 8.5% and having current market price of 1.02 of face value. How should the money be invested to get the maximum return at the child's eighteenth birthday?

6. (Optional) A company produces two products A and B over the next three months. The demand of both the products as well as the company's production capacity (in hrs.) varies each month. The production rates in units per hour are 0.75 and 1 for products A and B, respectively. All demands must be met; however, the company can produce more in earlier months to fill the demand of later months. The holding costs per unit per month are \$0.90 and \$0.70 for products A and B, respectively. The unit production cost for the two products are \$30 and \$28 for products A and B, respectively. Formulate the LP problem that can generate the optimum production schedule. (Be careful with the units).

	Month 1	Month 2	Month 3
Demand for Product A	500	5000	750
Demand for Product B	1000	1200	1200
Production Capacity (hrs.)	3000	3500	3000