Homework 4

1. Ασκήσεις: δείτε τις σελίδες 2-6 του παρόντος.

2. Πρόκειται για ατομικές ασκήσεις οι οποίες συνεισφέρουν το 25% του τελικού σας βαθμού.

3. Το παραδοτέο είναι ολόσωμο κείμενο Word όλων των ασκήσεων μαζί σε ελληνική γλώσσα μαζί με τα αρχεία δεδομένων των μοντέλων που κατασκευάσατε στο QSB (.gpp).

4. Όλα τα παραπάνω αρχεία θα πρέπει να συμπτυχθούν σε ένα zip αρχείο και να αποσταλούν ηλεκτρονικά (e-mail: tsantas@upatras.gr) στον διδάσκοντα μέχρι την 24.00 της 18ης Ιουλίου 2012. Στο μήνυμα πρέπει να αναφέρετε απαραίτητα το ονοματεπώνυμό σας. Εργασίες που παραλαμβάνονται εκτρόπθησαν επισύρονται βαθμολογικές κυρώσεις (0,5 βαθμό για κάθε ημερολογιακή ημέρα καθυστέρησης). Εργασίες που υποβάλλονται με καθυστέρηση μεγαλύτερη από 7 ημέρες δεν γίνονται δεκτές.


6. Στο κείμενο της εργασίας, για κάθε άσκηση, πρέπει να υπάρχει μια ενότητα με την εννοιολογική προσέγγιση, δηλαδή την περιγραφή του προβλήματος και των υποθέσεών του. Στη συνέχεια μια ενότητα με την ανάπτυξη του κατάλληλου μοντέλου και τέλος, μια ενότητα με τις απαντήσεις στα υπόλοιπα ερωτήματα της άσκησης.

7. Πίνακες αποτελεσμάτων του QSB πρέπει να είναι μέρος του κειμένου ως εικόνες.

8. Στην πρώτη σελίδα της εργασίας πρέπει να αναφέρετε το όνομα σας. Οι σελίδες είναι A4, όλα τα margins 2.5, to spacing 1.5 και η γραμματοσειρά Arial 12.
1. SMALL EXERCISES

A. The Milwaukee Theatre Guild has just received an anonymous $250,000 donation to be used as follows: block grants of $7500 each to children’s theater groups; grants of $6000 each for new playwrights; and grants for theater scholarships of $5000 each. The donor has stipulated that at least eight children’s theater groups must be funded. Other than that, the Guild may award the donation any way it sees fit. The Guild has determined the following goals.

- Award at least 40 block grants.
- Give at least 60% of the total funding to education (children’s theater and scholarships).
- Keep the number of scholarships from exceeding the number of new playwright award by more than five.
- Award at least 15 of each type of grant.

a. Formulate a nonpreemptive goal program with the weight of 4 for each detrimental deviation from goal 1, a weight of 3 for every $1000 deviation from goal 2, a weight of 2 for each detrimental deviation from goal 3, and a weight of 1 for each deviation from goal 4.

b. Solve for the recommended allocation of the funds.

B. With seven days to go before the Iowa presidential caucuses, Larry Adler, the campaign manager for Paul Powell, is trying to organize his staff and volunteers to contact potential voters by (1) phone, (2) household visits, and (3) personal contacts at local business establishments (restaurants, strip malls, etc.). A group of 10 full-time experienced staff members and 200 volunteers are trying to convince likely caucus voters that “Paul is the man!”

Full-time staff members work 12 hours per day, while volunteers average 5 hours per day. The following table summarizes Larry’s analysis of the situation.

<table>
<thead>
<tr>
<th></th>
<th>Phone Contacts</th>
<th>Household Visits</th>
<th>Total</th>
<th>By Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff member</td>
<td>5/hr.</td>
<td>3/hr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volunteer</td>
<td>8/hr.</td>
<td>4/hr.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum required</td>
<td>15,000</td>
<td>6,000</td>
<td>1500</td>
<td>200</td>
</tr>
<tr>
<td>Target goal</td>
<td>35,000</td>
<td>25,000</td>
<td>5000</td>
<td>700</td>
</tr>
</tbody>
</table>

Larry has decided to assign at least two experienced staff members to each of the three modes of voter contact. In addition, he feels that (1) each staff personal-contact hour below target is twice as detrimental as each total personal contact hour below target; (2) each total personal-contact hour below target is 100 times more detrimental than each household visit below target; and (3) each household visit below target is three times more detrimental than each phone contact hour below target.

a. Formulate and solve a nonpreemptive goal program for the allocation of experienced staff workers and volunteers during the 7 days.

b. Formulate and solve a nonpreemptive goal program for this problem if the two goals concerning personal contacts are considered priority 1 level goals and the two goals concerning phone and household visits are priority 2 level goals.
Larry Adler, campaign manager for Paul Powell (see exercise B), is also planning a television ad blitz during the seven days before the Iowa caucuses. Larry has produced two commercials for the Powell campaign. One is a 30-second upbeat positive ad showing Paul and his family on a picnic discussing issues that are important to Iowa voters. The second is a one-minute, negative attack against Paul’s principal opponent in the caucuses.

Larry has identified four possible television advertising options, determined ad costs and audience exposure, and estimated the maximum number of minutes available to run ads during the upcoming week, as shown in the following table.

<table>
<thead>
<tr>
<th>Television Type/Time</th>
<th>Minutes Available</th>
<th>Exposures per Ad</th>
<th>Cost per Ad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial/Daytime</td>
<td>70</td>
<td>45,000</td>
<td>60 sec-$10,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30 sec-$7,000</td>
</tr>
<tr>
<td>Commercial/Evening</td>
<td>35</td>
<td>250,000</td>
<td>60 sec-$40,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30 sec-$25,000</td>
</tr>
<tr>
<td>Cable/Evening</td>
<td>140</td>
<td>40,000</td>
<td>60 sec-$6,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30 sec-$5,000</td>
</tr>
<tr>
<td>Late night</td>
<td>200</td>
<td>8000</td>
<td>60 sec-$2,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30 sec-$1,500</td>
</tr>
</tbody>
</table>

“Exposures per Ad” indicates the number of likely voters who will see the ad (whether or not for the first time), not the number of new voters reached with each ad. Larry has determined the following goals for the television advertising:

**Priority 1**
Goal 1: At least 50% of the ads should be positive ads.

**Priority 2**
Goal 2: The campaign should spend less than $1 million on television advertising.

**Priority 3**
Goal 3: The ads should generate at least 5 million exposures.

**Priority 4**
Goal 4: The campaign should run at least 100 ads.
Goal 5: The campaign should run at least five positive ads in each of the four type/time slots.
Goal 6: The campaign should run at least 10 total ads during each of the four type/time slots.
Goal 7: The campaign should run at least 35 evening ads.
(Failing to meet goals 4 and 7 is twice as detrimental per ad as failing to meet goals 5 and 6.)

Formulate and solve a goal programming model to determine how Larry should advertise on television.

The pairings for the first round of the Southern Section high school basketball tournament are to be held on Wednesday night, and tournament officials must assign referee crews to officiate the games. The Southern Section is divided into four regions: (1) Los Angeles County, (2) Orange County, (3) Riverside County, and (4) San Diego County.

In the first round, teams play within their own area, but the officiating crew must be from another area; that is, a Los Angeles crew cannot referee a Los Angeles playoff game. The following table gives the number of playoff-qualified, two-man officiating crews available, the
number of games to be played in each area, and an estimate of the average driving distance between areas. Playoff officials are paid $50 each for a playoff game (a fixed expense); in addition, the Southern Section pays one of the officials (the “driving official”) 25 cents a mile. Each county is guaranteed a minimum of 12 playoff crew assignments.

The Southern Section has established the following priorities concerning the playoff official assignments:

Priority 1. Assign no more than 50% of the games in a county to officials from any one other county.
Priority 2. Assign at least 50% of the qualified official crews from each county.
Priority 3. Do not exceed more than $600 in total travel expenses.

a. What is your recommendation for game assignments if each goal is treated as a separate priority level?

b. Will your recommendation in part (a) change if the first two priorities are reversed?

c. How sensitive is your recommendation to changes in the maximum amount allowed for travel expenses?

<table>
<thead>
<tr>
<th>Average Driving Distances</th>
<th>Los Angeles</th>
<th>Orange</th>
<th>Riverside</th>
<th>San Diego</th>
<th>Number of Qualified Crews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles</td>
<td>xxx</td>
<td>40</td>
<td>50</td>
<td>120</td>
<td>42</td>
</tr>
<tr>
<td>Orange</td>
<td>40</td>
<td>xxx</td>
<td>35</td>
<td>90</td>
<td>24</td>
</tr>
<tr>
<td>Riverside</td>
<td>50</td>
<td>35</td>
<td>xxx</td>
<td>60</td>
<td>22</td>
</tr>
<tr>
<td>San Diego</td>
<td>120</td>
<td>90</td>
<td>60</td>
<td>xxx</td>
<td>30</td>
</tr>
<tr>
<td>Total first round games</td>
<td>26</td>
<td>18</td>
<td>16</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>
2. A CURE FOR CUBA

Fulgencio Batista led Cuba with a cold heart and iron fist—greedily stealing from poor citizens, capriciously ruling the Cuban population that looked to him for guidance, and violently murdering the innocent critics of his politics. In 1958, tired of watching his fellow Cubans suffer from corruption and tyranny, Fidel Castro led a guerrilla attack against the Batista regime and wrested power from Batista in January 1959. Cubans, along with members of the international community, believed that political and economic freedom had finally triumphed on the island. The next two years showed, however, that Castro was leading a Communist dictatorship—killing his political opponents and nationalizing all privately held assets. The United States responded to Castro's leadership in 1961 by invoking a trade embargo against Cuba. The embargo forbade any country from selling Cuban products in the United States and forbade businesses from selling American products to Cuba. Cubans did not feel the true impact of the embargo until 1989 when the Soviet economy collapsed. Prior to the disintegration of the Soviet Union, Cuba had received an average of $5 billion in annual economic assistance from the Soviet Union. With the disappearance of the economy that Cuba had almost exclusively depended upon for trade, Cubans had few avenues from which to purchase food, clothes, and medicine. The avenues narrowed even further when the United States passed the Torricelli Act in 1992 that forbade American subsidiaries in third world countries from doing business with Cuba that had been worth a total of $700 million annually.

Since 1989, the Cuban economy has certainly felt the impact from decades of frozen trade. Today poverty ravages the island of Cuba. Families do not have money to purchase bare necessities, such as food, milk, and clothing. Children die from malnutrition or exposure. Disease infects the island because medicine is unavailable. Optical neuritis, tuberculosis, pneumonia, and influenza run rampant among the population.

Few Americans hold sympathy for Cuba, but Robert Baker, director of Helping Hand, leads a handful of tender souls on Capitol Hill who cannot bear to see politics destroy so many human lives. His organization distributes humanitarian aid annually to needy countries around the world. Mr. Baker recognizes the dire situation in Cuba, and he wants to allocate aid to Cuba for the coming year.

Mr. Baker wants to send numerous aid packages to Cuban citizens. Three different types of packages are available. The basic package contains only food, such as grain and powdered milk. Each basic package costs $300, weighs 120 pounds, and aids 30 people. The advanced package contains food and clothing, such as blankets and fabrics. Each advanced package costs $350, weighs 180 pounds, and aids 35 people. The supreme package contains food, clothing, and medicine. Each supreme package costs $720, weighs 220 pounds, and aids 54 people.

Mr. Baker has several goals he wants to achieve when deciding upon the number and types of aid packages to allocate to Cuba. First, he wants to aid at least 20 percent of Cuba's 11 million citizens. Second, because disease runs rampant among the Cuban population, he wants at least 3,000 of the aid packages sent to Cuba to be the supreme packages. Third, because he knows many other nations also require humanitarian aid, he wants to keep the cost of aiding Cuba below $20 million.

Mr. Baker places different levels of importance on his three goals. He believes the most important goal is keeping costs down since low costs mean that his organization is able to aid a larger number of needy nations. He decides to penalize his plan by one point for every $1 million above his $20 million goal. He believes the second most important goal is ensuring that at least 3,000 of the aid packages sent to Cuba are supreme packages since he does not want to see an epidemic develop and completely the Cuban population. He decides to penalize his plan
by one point for every 1,000 packages below his goal of 3,000 packages. Finally, he believes the least important goal is reaching at least 20 percent of the population since he would rather give a smaller number of individuals all they need to thrive instead of a larger number of individuals only some of what they need to thrive. He therefore decides to penalize his plan by seven points for every 100,000 people below his 20 percent goal.

Mr. Baker realizes that he has certain limitations on the aid packages that he delivers to Cuba. Each type of package is approximately the same size, and because only a limited number of cargo flights from the United States are allowed into Cuba, he is only able to send a maximum of 40,000 packages. Along with a size limitation, he also encounters a weight restriction. He cannot ship more than six million pounds of cargo. Finally, he has a safety restriction. When sending medicine, he needs to ensure that the Cubans know how to use the medicine properly. Therefore, for every 100 supreme packages, Mr. Baker must send one doctor to Cuba at a cost of $33,000 per doctor.

a. How many basic, advanced, and supreme packages should Mr. Baker send to Cuba?

b. Mr. Baker reevaluates the levels of importance he places on each of the three goals. To sell his efforts to potential donors, he must show that his program is effective. Donors generally judge the effectiveness of a program on the number of people reached by aid packages. Mr. Baker therefore decides that he must put more importance on the goal of reaching at least 20 percent of the population. He decides to penalize his plan by 10 points for every half a percentage point below his 20 percent goal. The penalties for his other two goals remain the same. Under this scenario, how many basic, advanced, and supreme packages should Mr. Baker send to Cuba? How sensitive is the plan to changes in the penalty weights?

c. Mr. Baker realizes that sending more doctors along with the supreme packages will improve the proper use and distribution of the packages' contents, which in turn will increase the effectiveness of the program. He therefore decides to send one doctor with every 75 supreme packages. The penalties for the goals remain the same as in part b. Under this scenario, how many basic, advanced, and supreme packages should Mr. Baker send to Cuba?

d. The aid budget is cut, and Mr. Baker learns that he definitely cannot allocate more than $20 million in aid to Cuba. Due to the budget cut, Mr. Baker decides to stay with his original policy of sending one doctor with every 100 supreme packages. How many basic, advanced, and supreme packages should Mr. Baker send to Cuba, assuming that the penalties for not meeting the other two goals remain the same as in part a?

e. Now that the aid budget has been cut, Mr. Baker feels that the levels of importance of his three goals differ so much that it is difficult to assign meaningful penalty weights to deviations from these goals. Therefore, he decides that it would be more appropriate to apply a preemptive goal-programming approach (which will ensure that his budget goal is fully met if possible), while retaining his original policy of sending one doctor with every 100 supreme packages. How many basic, advanced, and supreme packages should Mr. Baker send to Cuba according to this approach?