**Integer Linear Programming: Additional Practice Problems**

*1)* *Managing Consultants.* You manage a small consulting firm with three clients. Minimize the total completion time of the projects by assigning **one** project leader to each client (each leader can only manage **one** client). The project completion times for each client and each project leader are summarized below.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Client** | | |
| **Project Leader** | **1** | **2** | **3** |
| Terry | 10 | 15 | 9 |
| Carl | 9 | 18 | 5 |
| Ann | 6 | 14 | 3 |

*2) Selecting Projects.* The Texas Electronics Company (TEC) is contemplating a research and development program encompassing eight major projects. The company is constrained from embarking on all projects by the number of available scientists (40) and the budget available for projects ($300,000).

Following are the resource requirements and the estimated profit for each project:

|  |  |  |  |
| --- | --- | --- | --- |
| **Project** | **Expense ($000)** | **Scientists Required** | **Profit ($000)** |
| 1 | 60 | 7 | 36 |
| 2 | 110 | 9 | 82 |
| 3 | 53 | 8 | 29 |
| 4 | 47 | 4 | 16 |
| 5 | 92 | 7 | 56 |
| 6 | 85 | 6 | 61 |
| 7 | 73 | 8 | 48 |
| 8 | 65 | 5 | 41 |

1. What is the maximum profit, and which projects should be selected?
2. Suppose that management decides that projects 2 and 5 are mutually exclusive. That is, TEC should not undertake both. As a result, what is the revised project portfolio and the revised maximum profit?
3. Suppose that management also decides to undertake at least two of the projects involving consumer products. (These happen to be projects 5-8.) As a result, what is the revised project portfolio and the revised maximum profit?

*Problems 3 and 4 are advanced and not relevant for exam in this course. Proceed at your own risk ☺*

*3) Car rental.* You are a small car rental business, and you must decide how many car categories to offer to your customers. Local laws require you to list all five categories on your website, even if you do not offer all of them: economy, compact, mid-size, standard and full-size. If you decide to offer a category, you incur a fixed cost of $20,000 per category (each category requires separate purchasing and insurance contract negotiations with the manufacturers). The demand for each category is as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | **1 (economy)** | **2 (compact)** | **3 (midsize)** | **4 (standard)** | **5 (full-size)** |
| Demand | 1000 | 2000 | 400 | 800 | 1000 |

If you decide to not offer a category, you must “upgrade”the customer by offering him a car from a higher category. Whenever you” upgrade” a customer, you incur an additional, variable cost: upgrade one level up costs you $50 (that is, it costs you $50 to upgrade someone from economy to compact, $100 from economy to midsize etc). If your objective is to minimize total costs, what categories should be offered?

*4)* *California Products Company.* California Products Company has the capability of producing and selling three products. Each product has an annual demand potential (at current pricing and promotion levels), a variable contribution, and an annual fixed cost. The fixed cost can be avoided if the product is not produced at all. This information is summarized as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| Product | Demand | Contribution ($) | Fixed Cost ($) |
| I | 290,000 | 1.20 | 60,000 |
| J | 200,000 | 1.80 | 200,000 |
| K | 50,000 | 2.30 | 55,000 |

Each product requires work on three machines. The standard productivities and capacities are as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Hours per 1,000 Unit | | |  |
| Machine | Product I | Product J | Product K | Hours Available |
| A | 3 | 4 | 8 | 1,900 |
| B | 3 | 4 | 6 | 1,900 |
| C | 2 | 3 | 10 | 1,900 |

a) Determine which products should be produced, and how much of each should be produced, in order to maximize profit contribution from these operations.

b) Suppose the demand potential for product K were doubled. What would be the maximum profit contribution?