**Answer to question 1 [15 marks]**

The description of the one-sided market problem should include a nomenclature and the mathematical formulation of the problem, in order to obtain full marks. The nomenclature should describe in detail the symbols used in the problem formulation.

Nomenclature:

means for all g from generators, we want that total sum of price times quantity for each generator to be minimum.

means the total sum of quantities along all generators

*Indices:*

*Parameters:*

)

quantity capacity of each generator (MW)

*Variables:*

quantities accepted of each generator (MW)

Problem formulation:

**Answer to question 2 [15 marks]**

The description of the two-sided market problem should include a nomenclature and the mathematical formulation of the problem, in order to obtain full marks. The nomenclature should describe in detail the symbols used in the problem formulation.

Nomenclature:

means sum of price times quantity for each generator for all g from generators.

means sum of price times quantity for each load for all l from loads.

means the total sum of quantities along all generators

means the total sum of quantities along all loads

*Indices:*

*Parameters:*

)

quantity capacity of each generator (MW)

)

quantity capacity of each load (MW)

*Variables:*

quantities accepted of each generator (MW)

quantities accepted of each load (MW)

Problem formulation:

**Answers to question 3 [20 marks]**

**3.1**) Fill the tables **[5 marks]**

One-sided market: bids

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Generator | 0 | 1 | 2 | 3 | 4 | 5 |
| Quantity (MW) | 60 | 50 | 20 | 0 | 10 | 10 |

Two-sided market: bids

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Generator | 0 | 1 | 2 | 3 | 4 | 5 |
| Quantity (MW) | 60 | 50 | 20 | 0 | 10 | 10 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Load | 0 | 1 | 2 | 3 | 4 | 5 |
| Quantity (MW) | 21 | 30 | 24 | 45 | 30 | 0 |

**3.3**) Fill the table **[5 marks]**

|  |  |  |
| --- | --- | --- |
|  | One-sided market | Two-sided market |
| Objective function value ($) | 4850 | -2647 |

**3.3**) Fill the table **[5 marks]**

|  |  |  |
| --- | --- | --- |
|  | One-sided market | Two-sided market |
| Marginal price ($/MW) | 39 | 40 |

**3.4**) **[5 marks]**

The two-side market is more cost-effective than one-side. One-side market will cost $4850 but two-side market will bring $2647 income.

**Answers to question 4 [10 marks]**

**4.1**) Fill the tables **[5 marks]**

Bids

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Generator | 0 | 1 | 2 | 3 | 4 | 5 |
| Quantity (MW) | 30 | 50 | 20 | 0 | 10 | 0 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Load | 0 | 1 | 2 | 3 | 4 | 5 |
| Quantity (MW) | 8 | 8 | 24 | 40 | 30 | 0 |

Branch power flows

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| From bus | 0 | 0 | 1 | 1 | 2 | 3 | 4 |
| To bus | 1 | 2 | 2 | 4 | 3 | 4 | 5 |
| Quantity (MW) | 40 | 40 | 40 | -28 | -32 | -40 | -20 |

**4.2**) **[5 marks]**

The constraints to accepted bids was the quantities of each generator, by applying network constraints, it actually adds more limits to the quantity. For this question, this means we can’t just accept the ideally cost-effective bids, sometimes we have to accept some expensive bids for specific generator, so, it will lead to the increase of marginal price to 44$/MW, and decrease the total income to 2122$.