

**15.066j System Optimization and Analysis**  
**Summer 2003**  
**Professor Stephen C. Graves**

**Group Problem Set 5**

**This problem set is due at the end of recitation on 17<sup>th</sup> July.**

**Problem 1:** An oil company produces three brands of oils: Regular, Multigrade and Supreme. Each brand of oil is composed of one or more of four crude stocks, each having a different viscosity index. The relevant data is:

Crude Stock	Viscosity index	Cost (\$/barrel)	Supply per day (barrels)
1	20	7.1	1000
2	40	8.5	1100
3	30	7.7	1200
4	55	9.00	1100

Each brand of oil must satisfy a minimum standard for viscosity index and each brand thus sells at a different price. The relevant data concerning the three brands are:

Brand	Minimum Viscosity Index	Selling Price (\$/barrel)
Regular	25	8.50
Multigrade	35	9.00
Supreme	50	10.00

One of three scenarios can occur:

	Low demand (prob. = 0.2)	Med. demand (prob. = 0.5)	High demand (prob. = 0.3)
Regular	1800	2000	2100
Multigrade	1300	1500	1600
Supreme	650	750	800

The company cannot sell more than its demand. Also any unused crude oil is disposed off at no cost. The decision of buying crude stock is taken well in advance and thus the company does not know what scenario holds at the time of buying crude stock. However at the time of production of oil the company knows the exact demand.

How much of crude stock must the company buy in order to maximize its expected profit?

**Problem 2:** The Auto company of America (ACA) produces 4 types of cars: subcompact, compact, intermediate and luxury. ACA also produces trucks and vans. Vendor capacities limit total production capacity to at most 1,200,000 vehicles per year. Subcompacts and compacts are built together in a facility with a total annual capacity of 620,000 cars. Intermediate and luxury are built together in a facility with a total annual capacity of 400,000 cars; and the truck/ van facility has a capacity of 275,000. Profit margins and fuel efficiencies are summarized below:

Type	Profit Margin (\$/vehicle)	Fuel Efficiency (MPG)
Subcompact	150	40
Compact	225	34
Intermediate	250	15
Luxury	500	12
Truck	400	20
Van	200	25

The company expects the demand level to be one of the three: **high demand** (with probability = 0.2), **medium demand** (with probability = 0.5) and **low demand** (with probability = 0.3). Note that the company does not know which scenario holds until the selling season arrives, long after it has taken its production decisions.

The demands for these scenarios is:

Type	High Demand (in '000)	Medium Demand(in '000)	Low Demand (in '000)
Subcompact	700	600	550
Compact	500	400	350
Intermediate	400	300	250
Luxury	325	225	175
Truck	425	325	275
Van	200	100	50

If the company ends up making more cars than the demand, it can sell its excess stock through a discount channel and earn half the normal profit; for example surplus compact cars would yield profits of \$112.5/ vehicle.

The average fleet fuel efficiency must be atleast 27 MPG.

What should the production plan of the company be so that its:

- a) Expected revenue is maximized
- b) Minimum revenue is maximized