Operations Research

Second Term Final Exam., 2009, 4th Year Students at Department of Mechanical Power Engineering.
Please solve the next problems. Graphics are necessary when possible. (Time: 3 hrs.)

1-A manufacturing company plans to open a new plant for one of its products. The company can build full-sized plant now or a small-sized plant that can be expanded 4 years later if high demand conditions prevail. Time horizon of this project is 12 years from now. The company estimates that the probabilities of high and low demands are always 0.75 and 0.25, respectively. Cost of immediate construction of a large plant is $8 millions. A small plant costs $3 millions. Expansion of the small plant costs $6 millions. Building large plant takes 6 months while building small plant takes 3 months which can be expanded later within 3 months. The income from this operation over the next 12 years is given in the next table.

Expansion of the small plant can be analyzed with 1-month market research at $400,000 regarding the potential demand level. Possible research findings are categorized as: (**1**) favorable research report (*FRR*), i.e. high demand is fairly likely; and (**2**) unfavorable research report (*URR*), i.e. low demand is fairly likely. Previous experience indicates that $P(FRR \setminus High\ Demand) = 0.6$ and $P(FRR \setminus Low\ Demand) = 0.3$. Report the optimal overall decision.

Decision of Plant Construction	Estimated Annual Income	
	High Demand	Low Demand
Building Large Plant now	$1,290,000	$600,000
Building Small Plant now	$500,000	$400,000
Expanding Small Plant after 4 years	$1,350,000	$450,000

2-A corporation recently has been enjoying an increase in sales of a stylish product over a year as shown in the next table. The corporation studies have reported that the sales will decrease next year following the inversed trend of the given year. Forecast the sales for Jan and Feb of the next year.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sales (in $ millions)	3.0	4.0	4.5	5.5	7.0	8.0	9.0	10.5	12.5	15.0	18.0	23.0

3-A maintenance person has the job of keeping four machines in working order. The amount of time that a machine works before breaking down has an exponential distribution with a mean of 10 hours. The time then spent to repair the machine has an exponential distribution with a mean of 2 hours. This person is regularly paid $15 per hour and he is paid additional $5 per repair hour. Each failure also costs an average of $40 for spare parts. The opportunity cost of an idle machine is estimated at $150 per hour.

(a) Construct the transition rate diagram of this process.
(b) Determine the expected cost per hour of this process.

4-A firm produces air filters for cars. This firm supplies a filter type at an average of 500 units monthly. The firm can produce this filter at an average rate of 50 filters per hour. Setup time of the equipment is estimated at 1.5 hours. Working time is charged at $90 per hour. Idle time is also estimated to cost $120 per hour in lost profit. The annual carrying cost rate is 20% based on the average inventory level. Each run, the materials are purchased instantaneously such that each filter costs $4.2 in addition to $100 per order. Shortage cost is $8 per filter per year. The firm sells each filter for $14. Assume that the demand during lead time, X, is stochastic with density function $f(x) = cx$ over the range 0 to 400 filters, where c is a real constant. Also, assume that backlogging isn't permitted. Apply 6-hour days, 20 working days per month, and 12 months per year. What is the optimal inventory policy? And how much it does gain?

My best wishes…….Dr. Hassan Soltan
Department of Production Engineering and Mechanical Design