Department Of Industrial Engineering & Management

Indian Institute of Technology, Kharagpur

End Term (Autumn Semester) Examination, 2012

Subject: Production Planning & Control

Subject No : IM 31007

Total Marks: 100 Time: 3hrs

Answer any five questions

1. **(a)** The sales data of a product of the last six weeks is given below.

Week j	1	2	3	4	5	6
Sales x_j	83	106	95	91	110	108

(i) Use a two week moving average to forecast for weeks 7 and 10. For initialization assume $x_0 = 100$

(ii) The manger suggests single exponential smoothing with $\alpha = 0.1$. Use the procedure to forecast for week 7 and 10. Assume initialization value $F_0 = 100$. Compute the value of MSE and MAD

(iii) Without doing all the computation, what would be the forecast in week 7 using exponential smoothing with $F_0 = 90$ 10

(b) Prove that simple M period moving average underestimates the forecasted demand when there is a linear increasing trend in data. 10

2. **(a)** We are predicting quarterly sales of an item of a departmental store using Winter's method. The following information is available: Seasonality factor: fall = 0.8 spring = 1.2 winter = 0.7 summer = 1.3 Current base estimate = 400 units per quarter ; Current trend estimates = 40 units per quarter; $\alpha = 0.2$, $\beta = 0.3$, $\gamma = 0.5$

Now sales of 650 units during the summer quarter are observed

(i) Use this information to update the estimates of base, trend and seasonality

(ii) After observing the summer demand, forecast demand for the fall quarter and the winter quarter. 10

(b) Suppose that simple exponential smoothing is being used to forecast a process. At the start of period t^*, the mean of the process shifts to a new level $\mu + \delta$. The mean remains at this new level for subsequent time periods. Show that the expected value of the exponentially smoothed statistics is 10

$$E(\hat{Y}_T) = \begin{cases} \mu, & T \leq t^* \\ \mu + \delta - \delta(1-\alpha)^{T-t^*+1}, & T \geq t^* \end{cases}$$

3. (a) A production plan is to be made for a product family where backorder is not allowed. Each worker produces 5000 units per month. Subcontracting and overtime production are possible options to supplement regular time production, and under time is paid. Overtime is limited to 15 percent of the regular time production in any month. D_t is demand in month t, W_t is the regular workforce in month t, H_t and L_t are hiring and layoff workforce at the beginning of month t, S_t and O_t are subcontracted and overtime production as product unit in month t, I_t is the inventory as product unit at the end of month t. Formulate this production planning problem as linear programming model.

In the next case, back order is allowed. Write the formulation of the problem. Notation should be clearly stated. 10

(b) A company has to supply its products to customers for the months November, December, January and February. It supplies customers as per their demand manufactured through regular and overtime production. The holding cost per unit per month is Rs. 1 and left over of one year's production cannot be sold in the subsequent years. The sales requirement, the production capacities and cost of production per unit are tabulated below. Determine the production schedule to minimize the cost of production. 10

Table: Data relating to the costs, sales and production

	November(2011)		December		January(2012)		February	
	R	OT	R	OT	R	OT	R	OT
Cost per unit (Rs)	6	8	5	8	7	9	7	10
Production Capacity	100	30	80	20	50	20	100	30
Sales requirement	80		80		110		120	

In the table, R = Regular time production; OT = Overtime production

4. (a) Consider the following instance of the job shop problem with no recirculation and make span as objective. Draw the network diagram for a disjunctive graph model and formulate it as disjunctive programming formulation. 10

Job	Machine sequence	Processing time		
1	1,2,3	$P_{11}=9$	$P_{21}=8$	$P_{31}=4$
2	1,2,4	$P_{12}=5$	$P_{22}=6$	$P_{42}=3$
3	3,1,2	$P_{33}=10$	$P_{13}=4$	$P_{23}=9$

Here P_{ij} represents job j to be processed in machine i.

(b) Suppose each job in a single machine-sequencing environment carries certain value. In such environment, define weighted mean flow time. Show that weighted mean flow time and average value of inventory in such machine environment are linearly related. Also show that WSPT rule is optimal for mean flow time. 10

5 Consider the following two machine job shop with 7 jobs. All jobs have to be processed first on machine 1 and then on machine 2. It implies that two machine job shop is actually a two machine flow shop.

Jobs	1	2	3	4	5	6	7
P_{1j}	3	6	4	3	4	2	7
P_{2j}	4	5	5	2	3	3	6

(a) Apply the heuristic for the above job shop problem with no recirculation and make span objective. Each time a machine is freed, select the job (among those immediately available for processing on the machine) with the longest total remaining processing (including its processing on the machine freed). If at any point in time more than one machine is freed, consider first the machine with the largest remaining work load. 10

(b) Apply Johnsons rule for the above problem to obtain the schedule and compare the make span of both the schedules. 10

6. **(a)** For the following data (assuming jobs are numbered in the order of their arrival), find the mean flow time, mean lateness, mean tardiness, and no of tardy jobs using the rule (i) FCFS (ii) SPT (iii) EDD (iv) CR 10

Job	1	2	3	4	5
Processing time (P_j) in days	5	3	9	7	15
Due date (d_j) day	10	8	11	16	22

(b) State the manufacturing resource planning (MRPII) process with a schematic diagram. 'ERP is an extension of MRP II' Justify the statement. 10

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