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Monday 28 April 2003      9 to 12

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Paper P2

ORGANISATION AND CONTROL OF MANUFACTURING SYSTEMS

*Answer not more than **four** questions*

*All questions carry the same number of marks.*

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

**You may not start to read the questions  
printed on the subsequent pages of this  
question paper until instructed that you  
may do so by the Invigilator**

1 A company manufactures two products, A and B, with the following Bill of Materials:

A	
	C
	D (2 off)
B	
	D
	E

Demand for Products A and B over the next 13 weeks is:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Product A	30	40	50	50	30	30	40	50	40	30	30	40	40
Product B	60	20	40	10	50	50	10	10	0	20	40	60	30

(a) Given the following data on lot sizing rules, lead times and inventory, calculate the Material Requirements Plan for all products and parts over the planning horizon.

[40%]

	Order quantity	Lead Time	On-Hand Inventory	Scheduled receipts (period 1)
<b>Product A:</b>	Economic Order Quantity = 67	2	53	67
<b>Product B:</b>	Fixed Order Quantity =100	1	100	
<b>Part C:</b>	Lot-for-Lot	3	72	67
<b>Part D:</b>	Minimum Order Quantity =100	1	100	
<b>Part E:</b>	Lot-for-Lot	1	0	

(b) Given the following data on routing and machine hours, calculate the capacity requirements using Capacity Bills [30%]

	Work centre	Batch size	Setup time (hours)	Run time (hours per unit)
Product A	1	50	2	0.10
Product B	1	100	2	0.05
Part C	1	50	2	0.06
Part D	2	50	1	0.05
Part E	2	20	1	0.01

(c) Without calculating the Capacity Requirements Plan for the Materials Requirement Plan calculated in part (a), explain how you would expect it to compare with the Rough Cut Capacity Plan using the Capacity Bills calculated in part (b). [30%]

2 (a) Define Supply Chain Management and explain how it differs from traditional purchasing and supply management. [30%]

(b) Explain why Electronic Data Interchange has declined in importance in recent years. [30%]

(c) Discuss, with examples, how computer-based information systems may affect the relationship between manufacturing companies and their suppliers. [40%]

3 An entrepreneur has built up a national chain of burger bars through three distinct stages: a single outlet, directly managed and run by himself; a chain of eight outlets in the same town; a national chain of 400 outlets.

(a) Regardless of the number of outlets:

(i) list the parameters that must be negotiated in the contract between entrepreneur and the suppliers of raw materials to the outlets; [20%]

(ii) describe the objectives of the entrepreneur in negotiating his contracts with these suppliers. [30%]

Ensure that your answers are specific to the burger bar business.

(b) Discuss the difficulties the entrepreneur might encounter in achieving the objectives you have identified in part (a) in each of the three stages of development listed above [30%]

(c) For the stage with 400 outlets, describe a simple stock control system to ensure co-ordination between suppliers and outlets. [20%]

4 (a) Using Spear and Bowen's approach, or otherwise, describe how the essence of the Toyota Production System may be communicated to a European manufacturing business as a set of rules. [30%]

(b) Illustrating your answer with practical examples, describe a range of approaches to ensuring that standardised operating procedures are communicated and followed. [35%]

(c) A British manufacturing business which has previously paid workers mainly on throughput is considering conversion to the Toyota Production System. What might be the main objections of the shop floor workers to the change and how would you advise management to address these objections? [35%]

5 A book retailer is studying inventory costs for their best selling product. This is a book which is delivered to individual stores in packs of 10 for £24 per pack. The manufacturer guarantees a 4-day delivery time to the retailer's warehouse.

The demand for these book packs over the past six months is shown below.

Month	January	February	March	April	May	June
Demand (in packs)	1940	2035	2025	2050	2000	1950

The retailer operates 250 days per year. Their annual cost of insurance, taxes, breakage, shrinkage, and warehouse is approximately 7% of the value of the inventory. The cost for placing an order is estimated to be £76, independent of the size of the order. The annual cost of capital is 11%.

- (a) The retailer currently orders 2000 packs monthly. If they were to change to an ordering policy based on the Economic Order Quantity, what order size should they use? [20%]
- (b) State the assumptions made in answering part (a) and discuss whether they are realistic in this context. [40%]
- (c) What would be the percentage change in annual cost, excluding purchase cost, if the retailer changed from its current ordering policy to the EOQ policy? [20%]
- (d) At what inventory level should the retailer order a new shipment of book packs from the manufacturer? [20%]

6 A manufacturer has a monthly demand of 12,000 units of its single product. All production occurs in a single facility that produces at a fixed rate per day. The manufacturer faces a production set-up cost of £20 and a storage cost of £6 per unit per year. For planning purposes, the firm assumes a 30-day month. At the conclusion of each production run, the firm's machinery must be examined at a cost of £10 for each inspection. The operations department has determined that it is most economical for the plant to produce 2,400 units during each production run.

- (a) Show that the Economic Order Quantity with Production ( $Q^*$ ) is:

$$Q^* = \sqrt{2d \frac{C_O}{C_H (1 - d/r)}}$$

where  $C_O$  = ordering cost,  $C_H$  = holding cost,  $d$  = demand,  $r$  = production rate. [40%]

- (b) For how many days during an order cycle is the production facility idle? [30%]

(c) The current production rate is known as the 'flat rate'. The manager has decided that, each month, the production rate will be decreased by 5% of the flat rate, so that it would be zero after 20 months. However, before this happens, it will be more economical to run production not in batches, but continuously. How long will it take to reach this point? [30%]

7 A manufacturing firm has three separate production facilities, numbered 2, 3, and 4, for three different products, P2, P3, and P4, respectively. Production facility  $i$  consists of  $i$  machines ( $i = 2, 3, 4$ ). Each facility has a list of 500 jobs to process each week. The processing time for each job on each machine at each facility is known.

(a) The firm would like to find, if possible, optimal solutions to three problems. In each case recommend an algorithm and specify whether you would expect to obtain an optimal solution from your approach.

(i) For P2, each job is to be processed once on each of two different machines and the firm wishes to minimise the makespan. [20%]

(ii) For P3, each job is to be processed on any one of three parallel machines and the firm wishes to minimise the makespan. [20%]

(iii) For P4, each job is to be processed on any one of four parallel machines and the firm wishes to minimise the mean flow time. [20%]

(b) A company employee claims to have found a schedule that minimises mean flow time but it is different from your solution in (a) part (iii). Before calculating the mean flow time for the new schedule, you notice that it has an even number of jobs being assigned to each machine. Explain carefully whether this schedule can be optimal. [40%]

8 A textile firm has ten jobs to complete by the end of a four-month period. Every job is processed in a chemical bath which can only process one job at a time. All jobs except  $c$  then proceed to a laborious hand treatment. For the hand treatment, as many additional workers as required can be brought in, but only one worker can work a single job at a time. The firm can subcontract jobs if necessary. The firm works on a 30-day month. The table below provides the number of days required to process each of the jobs, labelled  $a$  through  $j$ , in the two processes.

<i>Job</i>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>g</i>	<i>h</i>	<i>i</i>	<i>j</i>
Chemical bath	8	14	24	20	8	28	20	22	10	14
Hand treatment	20	24	none	36	18	50	28	14	26	12

(a) Find the minimum number of jobs that have to be subcontracted in order to meet the four-month deadline. Explain and justify the method you use to obtain your answer.

[60%]

(b) From next year, the firm will have a second chemical bath and will discontinue the use of subcontracting. The firm wishes to finish all ten jobs as soon as possible. Describe an appropriate method to schedule the work. Use the data above to illustrate how this method would work

[40%]

**END OF PAPER**