MANUFACTURING ENGINEERING TRIPOS PART I

Wednesday, 4 May 2011 9 to 12

PAPER 3

Module 3P4: OPERATIONS MANAGEMENT

Module 3P5: INDUSTRIAL ENGINEERING

*Answer **all questions** from Sections **A** and **B**.*

*Answers to sections **A** and **B** must appear in two separate booklets.*

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.*

STATIONERY REQUIREMENTS	SPECIAL REQUIREMENTS
20 page answer booklet x 2	Engineering Data Book
Rough work pad	3P5 Data Sheet
	CUED approved calculator allowed

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

Final version

SECTION A

1 (a) Define *theoretical capacity* of a manufacturing facility. Explain why the actual capacity of a manufacturing line is often different from its theoretical capacity. [20%]

(b) Customers arrive at a telephone booth approximately every 10 minutes. The length of an average phone call is 4 minutes. Calculate:

(i) the probability that a customer arriving at the booth will have to wait;

(ii) the average waiting time in the queue. [15%]

(c) Explain the drawbacks of a traditional Material Requirements Planning (MRP) scheduling system. [15%]

(d) Explain the *bullwhip effect* in the context of supply chain management. Discuss how the consequences of the bullwhip effect may be reduced. [20%]

(e) In the context of demand forecasting, discuss the accuracy of the following forecasting techniques: simple moving average, weighted moving average, exponential smoothing and linear regression analysis. [15%]

(f) The following table gives the processing times and due dates for five jobs which are to be processed sequentially on a machine. Assign the order of jobs to minimise average time to completion and explain the rationale for your answer. Calculate the mean flow time and the average lateness. [15%]

Job	A	B	C	D	E
Processing time (Days)	6	7	4	9	5
Due Date (Days Hence)	5	3	4	7	2

2 A hardware wholesale store stocks a popular 19.2 volt cordless drill that is sold on demand to retailers throughout Cambridgeshire. The store operates 5 days per week, 52 weeks per year. Only when it is open for business can orders be received. Average daily demand is 100 drills, with an order lead time of 3 days. The order cost is £35 per order, and the holding cost is £9.40 per drill/year. In addition to the cycle inventory, a buffer stock of 1.5 days' sales is held in case of unexpected customer demand. The purchase cost of each drill is £40. A Fixed Order Quantity system is used for inventory management.

(a) What is the order quantity Q to be used by the store in order to minimise the total annual cost? Calculate the corresponding reorder point R that should be used. [25%]

(b) What is the total annual cost of the fixed order quantity system for the store? [15%]

(c) The store's current inventory policy calls for order quantities of 380 drills. What is the extra cost the store incurs due to this policy as compared to the Fixed Order Quantity system? [10%]

(d) Comment on the sensitivity of the Economic Order Quantity (EOQ) model for inventory management to errors in demand and cost estimates. [15%]

(e) The store is contemplating to move to a Fixed Time Period system for inventory management. Explain the difference between the two inventory management systems, and discuss their relative advantages and disadvantages. [25%]

(f) With all other data the same, calculate the review period, P (in workdays, rounded to the nearest day) for a Fixed Time Period system that gives approximately the same number of orders per year as the order quantity used in the Fixed Order Quantity system. [10%]

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SECTION B

3 (a) Define *manufacturing strategy*. Why is it essential to understand the manufacturing strategy of a company before applying industrial engineering techniques to the redesign of a production system? [10%]

(b) Briefly outline the basic procedure for Method Study. [10%]

(c) Discuss the concept of a Standard Operating Procedure (SOP) in the context of a manufacturing operation. Explain why a SOP is important. [10%]

(d) A male worker works an eight-hour shift consisting of performing a repetitive task with a 5-min work cycle. During each cycle, his energy expenditure rate is 8.1 kcal/min for 25% of the time, and 5.3 kcal/min for the remaining 75%.
Suggest a suitable schedule for rest breaks. [10%]

(e) Define the following terms, and briefly describe their use in the design and operation of a manufacturing system:

(i) Takt time;
(ii) Poka-yoke;
(iii) Overall Equipment Effectiveness (OEE);
(iv) In the context of capability measurement, C_p and $C_{pk.}$ [20%]

(f) Describe the principles behind a cellular layout for manufacturing machined components, and outline its advantages and disadvantages compared to a functional layout. [15%]

(g) Using Garvin's Dimensions of Quality, or otherwise, discuss what is meant by *product quality.* [15%]

(h) A manufacturing process has a defect rate of 10 percent, based upon 50 samples of 30 data points each. Calculate the control limits for a p-chart, and explain how it would be used to detect changes in the process performance. [10%]

4 (a) Discuss the reasons for having *standard times* for manufacturing operations. [10%]

(b) Define *time study*. Describe in detail the process for setting standard times using time study. [35%]

(c) Compare the relative advantages and disadvantages of using *time study* compared to *predetermined motion time systems (PMTS)* for setting standard times. Identify the circumstances where each might be appropriate. [30%]

(d) A work study engineer measured the time taken for 5 successive repetitions of a simple assembly operation. The results were as follows:

Observation	Time (s)
1	137
2	128
3	126
4	123
5	118

Use this data to calculate 95% confidence limits for the observed time. Discuss whether this time study provides a valid basis for setting a standard time. [25%]

END OF PAPER