ENGINEERING TRIPOS PART IIA

Monday 21 April 2008 9.00 - 10.30

Module 3E10

OPERATIONS MANAGEMENT FOR ENGINEERS

*Answer not more than **two** questions.*

All questions carry the same number of marks.

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

There are no attachments.

STATIONERY REQUIREMENTS	SPECIAL REQUIREMENTS
Single-sided script paper	None

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

Version: Final-

1 Based on your reading of the article, 'Controlling Variation in Health Care: A Consultation from Walter Shewhart', answer the following questions:

(a) Explain the key features of Total Quality Management. [40%]

(b) What does *systems of chance cause* mean as defined by Shewhart? Compare this with Demming's concept of *common causes*. [30%]

(c) What does Shewhart mean by *assignable causes*? [30%]

2 A firm in Birmingham is the exclusive producer of a compound that is used in the manufacture of silicon chips. Monthly demand for the compound is 50,000 kilograms. The fixed cost of setting up for a production of the compound is £1500, and the variable cost of production is £3.50 per kilogram. The firm can produce the compound at a rate of 10,000 kilograms per day. The company uses an annual interest rate of 22% to account for the cost of capital, and the annual cost of storage of the chemical amounts to 12% of the value. Assume that there are 250 working days in a year.

(a) Find the optimal size of the production run for this compound. [40%]

(b) What proportion of each cycle consists of 'uptime', i.e., the production portion of the cycle? [20%]

(c) What is the maximum level of on-hand inventory? [20%]

(d) What is the annual average cost of holding and setup attributed to this compound? [20%]

3 (a) Provide a definition of the term *bottleneck* in an operations management context, and explain its significance with respect to the output of an organisation. [20%]

(b) Goldratt and Cox point out that a certain rule must be established with regard to the work at the bottleneck in a manufacturing environment. Briefly explain that rule. [20%]

(c) Describe two negative effects of a non-bottleneck operation running faster than the bottleneck in a manufacturing environment. [40%]

(d) Choking the release of non-bottleneck machines in order that they run at the full capacity speed of the bottleneck can have several beneficial effects. List two of these effects and identify issues that might be faced in achieving them. [20%]

4 When inventory cost is a significant component of total manufacturing cost, in scheduling jobs we seek to minimise the *weighted completion time*. Each job j has an associated weight w_j, and we wish to minimise the sum over all jobs of the product $w_j t_j$, where t_j is the time at which the processing on job j is complete. Suppose we have a single-machine setting with four jobs. In the table below, p_j denotes the processing time of job j.

job	w_j	p_j
1	6	3
2	11	5
3	9	7
4	5	4

(a) Find a sequence that minimises the weighted completion time and find the value of the objective. Is there only one optimal sequence? [20%]

(b) Give an argument for positioning jobs with larger weight more toward the beginning of the sequence and jobs with smaller weight more toward the end of the sequence. [20%]

(c) Give an argument for positioning jobs with smaller processing time more toward the beginning of the sequence and jobs with larger processing time more toward the end of the sequence. [20%]

(d) Which one of the following four generic rules is most suitable for the problem?

Rule 1: Sequence the jobs in decreasing order of $w_j - p_j$.

Rule 2: Sequence the jobs in decreasing order of w_j / p_j.

Rule 3: Sequence the jobs in increasing order of $w_j - p_j$.

Rule 4: Sequence the jobs in increasing order of w_j / p_j. [20%]

(e) Give a proof that the most suitable rule always results in the optimal schedule. [20%]

END OF PAPER