Version AP/7

MET2
MANUFACTURING ENGINEERING TRIPOS PART IIA

Thursday 4 May 2017 9 to 12

Paper 3

Module 3P4: OPERATIONS MANAGEMENT
(Section A)

Module 3P5: INDUSTRIAL ENGINEERING
(Section B)

*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.*

*Write your candidate number **not** your name on the cover sheet.*

STATIONERY REQUIREMENTS
20 page answer booklet x 2
Rough work pad

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
Engineering Data Book
CUED approved calculator allowed
3P5 Data Sheet

10 minutes reading time is allowed for this paper.

You may not start to read the questions printed on the subsequent pages of this question paper until instructed to do so.

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SECTION A

1 (a) Describe two ways in which manufacturing capacity is measured, providing examples in each case. [20%]

(b) CamCars produces automobile sub-assemblies. It employs 24 assemblers working on a single production line where work is passed from one operator to the next. Working a single 8-hour shift, 5 days a week, the current capacity of the plant is 1200 units a day. The current production line only makes use of 40% of the production floor area and the rest of the area is unused.

CamCars' sole customer has just produced a revised forecast of daily demand for the next 12 months, as shown in Fig. 1.

Month	Average daily demand
1	1200
2	1320
3	1320
4	1380
5	1380
6-12	2200

Fig. 1

In the past the customer has always produced accurate forecasts, and hence it is not expected that these figures will change.

A number of manufacturing options are being considered by the company to raise capacity during the next 12 months including overtime, additional shifts, additional assembly lines, and different shift patterns.

(cont.

Explain the advantages and disadvantages for the company in adopting each of these options. What further information should the company seek in order to develop a 12 month production plan? [40%]

(c) SBC Ltd. sells a popular city bicycle named the Cruiser. The lead time for the assembly of the Cruiser is 3 days. The gross requirements for the Cruiser over the next seven days are 100, 150, 200, 100, 300, 450 and 500 bicycles. Currently, there are χ Cruiser bikes in inventory, and an assembly order for 50 Cruisers is scheduled to be completed by the beginning of day 2. SBC uses MRP to determine the order release times. The lot size for Cruisers is fixed at 700 bicycles.

(i) What is the smallest value of χ that will help SBC avoid any shortages? [15%]

(ii) Using the value of χ calculated in part (i), determine the order release times for the Cruiser over the next seven days. [25%]

2 (a) The Economic Order Quantity (EOQ) model has been criticised due to its 'unrealistic' assumptions. Explain how the assumptions made in determining EOQ are not matched by reality. To what extent is the validity of the EOQ model affected by these issues? [30%]

(b) A glass producer requires 10,000 metric tons of soda ash each year. A metric ton of soda ash costs £300. The ordering cost is £10,000. The annual holding cost of inventory is 15% of the item cost.

(i) Determine the Economic Order Quantity and the corresponding optimal costs. [15%]

(ii) Suppose that the supplier offers a discount such that the purchasing price for soda ash drops to £295/metric ton if the company purchases at least 3,000 metric tons in an order. An analyst has calculated that the total cost, $C(Q)$, incorporating annual inventory and setup, is £99,708 using Q=3,000 tons. The analyst concludes that the company should not order 3,000 tons at a time. Is the analyst correct in his conclusion? Explain the rationale for your answer. [25%]

(iii) Suppose now that the supplier offers a deal such that if the company purchases more than 4000 metric tons, the supplier will offer £10,000 cash as rebate and the purchasing price for items in excess of 4000 metric tons will be £290/metric ton instead of its regular price of £300. Determine the optimal order quantity. [30%]

SECTION B

3 (a) Define *time study* and describe how this method is used to set accurate time standards for manual manufacturing operations. [30%]

(b) A new operator is part of the way through manufacturing her first batch of components. After 98 components have been manufactured, an engineer measures the time taken for the next three components (i.e., components 99, 100 and 101) with the following results: 59.1 s, 62.2 s, 58.4 s.

(i) Calculate 95% confidence limits for the basic time for the manufacturing operation. State any assumptions made. [25%]

(ii) Assuming that this manufacturing operation has a 90% learning curve, calculate the time taken to produce the next 100 components. [25%]

(iii) Evaluate and discuss whether this learning curve model can be applied to a batch of 500 and a batch of 5000. [20%]

4 (a) Describe how statistical process control tools are used to examine the capability of manufacturing processes to produce within customer requirements. [20%]

(b) A manufacturing process has a defect rate of 5 percent, based on 10 samples of 20 data points each.

(i) Calculate the control limits for a *p*-chart for this process. [10%]

(ii) Explain using examples, how a *p*-chart can be used to detect changes in process performance. [20%]

(c) A factory has two manufacturing lines that deliver precision ceramic washers for a new type of tap fitting. Both lines operate under the same standard operating conditions. The Upper Specification Limit of the lines for the thickness of the washers is 3.52 mm and the Lower Specification Limit is 3.18 mm. Line 1 produces washers with a mean thickness of 3.35 mm and a standard deviation of 0.07 mm. Line 2 produces washers with a mean thickness of 3.43 mm and a standard deviation of 0.05 mm.

(i) For each line, calculate the C_p and C_{pk} values, and the percentage of parts that are within the specification limits. [30%]

(ii) Discuss the implications of your calculations and describe how the production process might be improved. [20%]

END OF PAPER