Version Final

MET2
MANUFACTURING ENGINEERING TRIPOS PART IIA

Thursday 1 May 2014 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.*

Write your candidate number not your name on the coversheet.

STATIONERY REQUIREMENTS
20 page answer booklet x 2
Rough work pad

SPECIAL REQUIREMENTS
Engineering Data Book
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 to do so.

SECTION A

1 (a) Briefly outline the costs that should be considered when determining the appropriate levels of inventory to hold and at what location to hold it. [15%]

(b) The outbound warehouse of a lubricant production company receives an average of 1,000 barrels per week to send to the wholesaler. There are, on average, 500 barrels waiting already in the outbound warehouse. What is the average time spent in the warehouse by each barrel being sent to the wholesaler? [15%]

(c) Of the barrels arriving at the outbound warehouse described in part (b) 80% are classed *small* with an average value of £500 and 20% are classed *large* with an average value of £5,000. The processing times of the large and small barrels are identical and hence, on average, 20% of the barrels waiting are large and 80% small. It is proposed to reallocate resources in the warehouse (at no additional cost to the company) so that large barrels are dealt with more quickly with an average waiting time of 0.3 weeks, while small barrels will wait an average of 0.8 weeks before being processed. Assume that the demand for the barrels is unlimited, once barrels are sent the wholesaler pays, barrels are sent individually, and the waiting times for barrels do not affect the product.

(i) Is it worthwhile to reallocate resources as described above? Justify your answer. [10%]

(ii) By what percentage would the new policy for handling barrels decrease or increase holding cost? [35%]

(d) The company's main barrel supplier has been having delivery issues. As a result the lubricant company has been subject to some significant disruptions. Discuss the role that inventory might play in managing such disruptions and how it might influence the way the company manages its operations. [25%]

2 (a) A new consumer goods retailer is setting up its operations in the UK and is examining several logistics issues for its range of product offerings.

(i) Providing an appropriate rationale, explain which types of product it should consider for direct shipping from the supplier to the retail outlets and which types would be more suitably shipped via an intermediate warehouse. [20%]

(ii) Explain what is meant by the term *transhipment* in the context of warehouse management. Indicate under which circumstances the new retailer might consider using transhipment. [15%]

(b) For one supplier of a key product, volumes are sufficient that several factories will be used to supply the retailer via intermediate warehouses. Fig. 1 provides a table outlining:

- the daily demand at each of three warehouses A, B, C,
- the daily production at each of four supplier factories I, II, III, IV, and
- the transport cost per item between each factory-warehouse pair.

(i) State the basic principles of the North West corner approach for allocating supply to demand. What are the limitations of this approach? [10%]

(ii) Find an initial North West corner allocation for the configuration in Fig. 1 and calculate the total distribution cost associated with that allocation. [20%]

(iii) Demonstrate that it is possible to reduce the total distribution cost in part (ii) by at least £100 per day by using a suitable heuristic. [10%]

iv) A planning change means that the daily demands for Warehouses A, B, C are now 180, 150, 120 items respectively. Discuss the implication of this change for your allocation, and indicate how you would revise your calculations in (ii) and (iii) to accommodate this change. [25%]

	Warehouse A	Warehouse B	Warehouse C	Production
Factory I	(£1.80)	(£1.50)	(£2.80)	180
Factory II	(£2.40)	(£3.60)	(£3.00)	90
Factory III	(£2.20)	(£1.20)	(£1.60)	130
Factory IV	(£4.00)	(£4.20)	(£1.40)	100
Demand	120	210	170	500

Fig. 1

SECTION B

3 (a) Define *manufacturing strategy*. Discuss why it is 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 factors you would include in an audit of the physical working environment of a factory comprising a forge, a general machine shop, and an assembly department. Explain why each factor would be included, relating it to the effect it might have on human performance, and identifying the areas where it is likely to be particularly important. [25%]

(d) A male worker works an eight-hour shift consisting of performing a repetitive task with an 8-min work cycle. During each cycle, his energy expenditure rate is 9 kcal/min for 25% of the time, and 5 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) Kaizen. [25%]

(f) (i) Using Garvin's Dimensions of Quality, or otherwise, discuss what is meant by *product quality.*

(ii) In the context of capability measurement, discuss what is meant by C*p* and C*pk.*

(iii) A manufacturing process has a defect rate of 8 percent, based upon 30 samples of 40 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. [25%]

4 (a) Explain why companies have *standard times* for manufacturing operations. [15%]

(b) Briefly describe the main methods used for setting time standards, and compare the relative advantages and disadvantages of using *time study* or *predetermined motion time systems (PMTS)* for this task. [50%]

(c) An industrial engineer measured the time taken for 3 successive repetitions of a simple light assembly operation. The results were: 28.6 s; 31.4 s; and 30.0 s. Analysing the operation using MTM-1 resulted in a time of 1104 TMU. The standard time for the operation was recorded as 37.6 s in the company's production engineering database.

(i) Calculate 95% confidence limits for the observed time.

(ii) Calculate the basic time from the MTM analysis.

(iii) Compare these times with the time in the company's database. Comment on any differences and explain why such differences might occur. [35%]

END OF PAPER