## Version AP/6

MET2
MANUFACTURING ENGINEERING TRIPOS PART IIA

Monday 30 April $2018 \quad 9.00$ to 12.10

## Paper 3

Module 3P4: OPERATIONS MANAGEMENT
(Section A)

Module 3P5: INDUSTRIAL ENGINEERING
(Section B)

Answer all questions from sections $\boldsymbol{A}$ and $\boldsymbol{B}$.
Answers to section 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 TO BE SUPPLIED FOR THIS EXAM
CUED approved calculator allowed
Engineering Data Book
3P5 Data Sheet

10 minutes reading time is allowed for this paper at the start of the exam.

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 You are the operations manager of FancyFences Ltd, manufacturer of garden fence panels. The panels are produced through four main stages: timber cutting, painting, assembly and packing. The total processing time is 2 hours and 10 minutes per panel. A shift has 7.5 hours, and the factory is running for two shifts a day. Each month has 20 working days. The average demand is 14,400 units per month. The current work in progress (WIP) inventory level for all production stages combined is 180 units.
(a) (i) Discuss the role of inventory in a manufacturing system.
(ii) In the case of FancyFences, what is the minimum WIP inventory level possible to meet the demand? State any assumptions you make.
(b) The marketing department at FancyFences is investigating different demand forecasting approaches.
(i) Describe three different approaches to demand forecasting. Discuss the strengths and weaknesses of each.
(ii) FancyFences found that sales are very seasonal, with exponential growth periods in the months leading up to the summer. What demand forecasting approach should be used to predict the company's future sales? Justify your answer.
(c) The marketing department is examining the development of the garden fence market over the next five years. What economic indicators would you recommend them to consider in their analysis?

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2 An assembly line has nine separate operations. The duration and immediate precursors of each operation are given in Fig. 1. The line works 8 hours per day with two 15 minute breaks.

| Operation | Duration (minutes) | Precursors |
| :---: | :---: | :---: |
| A | 6 | - |
| B | 4 | - |
| C | 3 | A |
| D | 3 | $\mathrm{~A}, \mathrm{~B}$ |
| E | 4 | $\mathrm{C}, \mathrm{D}$ |
| F | 9 | D |
| G | 3 | $\mathrm{E}, \mathrm{F}$ |
| H | 4 | G |
| I | 1 | G |

Fig. 1
(a) You are asked to improve the balance of the line.
(i) Draw a suitable diagram depicting the assembly process.
(ii) Determine the minimum number of workstations required to balance the line to meet a daily demand of 50 units. Clearly describe the method you use and show the operations to be completed at each workstation.
(iii) Evaluate the performance of the resulting solution, commenting on the minimum number of workstations required and the balancing loss for your solution.
(b) The company wants to increase line capacity to 100 units per day, which would enable it to buy raw materials in larger quantities at bulk discount. What changes can be made to the assembly line for it to be able to accommodate this increase?
(c) Under what circumstances should the company consider adding capacity
(i) before demand has increased?
(ii) after demand has increased?

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## SECTION B

3 (a) An assembly worker is performing a repetitive manual task consisting of inserting 8 plastic pegs into 8 holes in a flat wooden board. The following steps are involved in this task:

- The worker sits at the centre of a worktable. Using her right hand, the worker reaches for the top board from a stack of boards, picks it up, and places it in her left hand. The stack of boards is located about 45 inches to the left side from the centre of the worktable.
- While holding the board in her left hand, the worker picks up the pegs from a tray about 20 inches away in front of her with her right hand and inserts them into the holes in the board, one peg at a time. An interference fit is involved in each insertion.
- The worker then places the assembled board into a rack that is next to the stack of boards. The rack holding the completed boards has a capacity of six assemblies.
- When the rack is full, the worker gets up from her worktable, picks up the loaded rack, carries it to a pallet located on the floor three feet away from the workplace, and places it onto the pallet. The pallet can hold four racks.

A material handling worker riding in a forklift truck must periodically take the pallet away and replace it with an empty pallet. The assembly worker is occasionally forced to stop working and wait for the pallet exchange to occur.
(i) Identify the principles of motion economy that are violated in this work cycle. Justify your answer.
(ii) What recommendations for productivity improvement would you make from the point of view of motion economy?

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(b) The worker is currently exposed to two co-existing sources of noise during an 8hour work shift, one at 83 dBA and the other at 86 dBA . The noise results from two production machines that are near the worker. Management wants to install a third production machine that will expose the worker to an additional noise source of 92 dBA .
(i) Determine the average level of noise the worker is exposed to before the third machine is introduced.
(ii) Determine to what dBA level must the noise of the third machine be reduced in order to satisfy the requirements imposed by the UK Noise Regulations (2005).
(iii) Discuss the steps that management could take to reduce the noise exposure level of the worker if the third machine is installed.

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4 (a) Describe the differences between a cellular production layout, product layout, and process layout, and discuss the advantages and disadvantages of each.
(b) A manufacturing company is planning to acquire an existing building to set up its new factory. The factory will have six production departments: M (milling), D (drilling), T (turning), G (grinding), F (finishing), and A (assembly). Fig. 2 shows the proposed layout of the factory, where the thick lines indicate existing building walls. Products will be routed for processing through these departments in the quantities and sequences indicated in Fig. 3.
$\left.\begin{array}{|l|l|l|l|l|l|l|l|l|}\hline & & & & & & & & \\ \hline & \mathrm{M} & & & \mathrm{A} & & & & \mathrm{T}\end{array}\right)$

Fig. 2

| Product | Quantities per day | Sequence |
| :---: | :---: | :---: |
| 1 | 40 | M-D-F-A |
| 2 | 50 | T-G-F |
| 3 | 20 | T-D-F |
| 4 | 60 | G-F-A |
| 5 | 70 | M-D-M-G-F |
| 6 | 30 | T-M-F-A |
| 7 | 10 | M-T-G |

Fig. 3
(i) Calculate the Layout Efficiency Rating of the proposed layout.
(ii) Clearly explaining your approach, propose an alternative layout for the factory that improves the Layout Efficiency Rating.
(iii) Discuss other considerations that should be taken into account when designing the layout of the factory.

## END OF PAPER

