Version MS/04

MET 2

MANUFACTURING ENGINEERING TRIPOS PART IIA

Monday 29 April 2024   9:00 to 12:10

Paper 3

MODULE 3P4: OPERATIONS MANAGEMENT
MODULE 3P5: INDUSTRIAL ENGINEERING

Answer ALL questions from sections A and B.

Start each question in a new booklet.

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 of each booklet.

STATIONERY REQUIREMENTS

8 page answer booklet x 4

Rough work pad

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM

CUED approved calculator allowed

Engineering Data books

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.

You may not remove any stationery from the Examination Room.

SECTION A

Answer all questions from this section.

Question 1

CamBuild is a company specialising in offsite construction and the assembly of modular housing units using eco-friendly materials. The daily operations as outlined in Table. 1, details the duration and immediate precursors of each operation for assembling one unit. The assembly line operates for 8 hours each day including three 10-minute breaks.

Operation	Duration (in minutes)	Precursors
A	6	-
B	3	-
C	2	A
D	2	A,B
E	3	C,D
F	8	D
G	2	E,F
H	3	G
I	1	G

Table 1

(a) You are asked to improve the balance of the line.

    (i) Draw a diagram depicting the assembly process.

[10%]

    (ii) Determine the minimum number of workstations required to balance the line to meet a daily demand of 75 units. Outlining the operations to be completed at each workstation, comment on the balancing loss for your solution.

[30%]

(b) The company aims to boost the line capacity to 200 units per day. What modifications can be implemented in the assembly line to accommodate this increase?

[30%]

(cont.

(c)   You are tasked with forecasting the demands for the modular housing units. Discuss the different forecasting methods outlining the advantages and disadvantages of each method.

[30%]

Question 2

(a)   Explain the differences between the characteristics of service operations and manufacturing operations. Give examples as appropriate. To what extent do you think this distinction is valid?

[25%]

(b)   Explain the following terms: cycle stock, safety stock, pipeline stock, and anticipation stock. Discuss the function of each of these inventory types. How can a company decrease them?

[25%]

(c)   What are the key capacity decisions companies need to make? Discuss the key challenges of capacity planning.

[25%]

(d)   Explain the difference between order qualifiers and order winners.

[25%]

SECTION B

Answer all questions from this section.

Question 3

(a) A work sampling study was performed on four sales executives in a company who make all their sales through telephone solicitations. A total of 500 observations were made over a period of one week (seven hours per day, five days per week). The categories of activity and number of observations per category are given in Table. 2.

Category	Description	Number of observations
1	telephone calls	164
2	filing and sorting	150
3	reading and research	101
4	personal and non-productive time	85

Table 2

Previous analysis has shown that total sales are proportional to the time spent on the telephone. Total sales during this period were £525,000 and the company earned a profit of 4% on these sales.

(i) Estimate how many hours were spent on the telephone by the four sales executives during the one-week period.

[10%]

(ii) Construct a 97% confidence interval on the proportion of time spent on telephone calls during the one-week period.

[30%]

(iii) The company is considering hiring a clerk for 7 hours a day at £750 per week to do the filing and sorting. This would reduce the time spent by the sales executives on these activities since the clerk will do filing and sorting for 7 hours every day. Will the increase in profit cover the cost of employing the clerk? Make the case for this decision with appropriate calculations and explanations for the assumptions made.

[40%]

(cont.

(b) A sales office is lit by 50 lights, positioned at a height of 5 metres. Calculate how many lights can be removed, while maintaining the same level of illuminance, if lights are repositioned at a height 3 meters instead? And explain how would the lighting requirements be different between a sales office and workshop?

[20%]

Question 4

(a) A direct time study was performed for a task. The regular cycle consisted of four elements, t, u, v and w. Elements x and y are irregular elements performed every six and four cycles respectively. The performance rating for each element is shown in Table 3.

Work element	t	u	v	w	x	y
Observed time (min)	0.50	0.25	0.58	0.72	0.85	1.01
Performance rating	80%	100%	95%	100%	100%	95%

Table 3

   (i) Calculate the basic time and the standard time for the cycle using an allowance factor of 17%.

[25%]

   (ii) For the 2024 production, element z will replace element x. The observed time of the element z is estimated to be 0.62 min and the performance rating will be 95%. Calculate the basic time and the standard time for the cycle using the same allowance factor of 17%.

[25%]

(cont.

(b) A production machine is scheduled to run for 10 shifts per week. Each shift lasts for 7.5 hours. The standard cycle time for producing a component on this machine is 4.5 minutes. Due to a breakdown, the machine was not operational for 3 hours. The machine operator was not available on one of the ten scheduled shifts. Whilst running, the machine was producing 10 components an hour. The average scrap rate was 3%. Using the information provided, calculate the OEE for this machine for a given week. State the assumptions made.

[10%]

(c) In the context of a manufacturing facility, describe the advantages and disadvantages of a functional layout and a cellular layout. Give examples to support your answer and include appropriate sketches.

[40%]

END OF PAPER