Version FE/2

EGT2
ENGINEERING TRIPOS PART IIA

Thursday 6 May 2021 1.30 to 3.10

Module 3E10

OPERATIONS MANAGEMENT FOR ENGINEERS

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

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 and at the top of each answer sheet.*

STATIONERY REQUIREMENTS
Write on single-sided paper.

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM CUED approved calculator allowed.
You are allowed access to the electronic version of the Engineering Data Books.

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

The time taken for scanning/uploading answers is 15 minutes.

Your script is to be uploaded as a single consolidated pdf containing all answers.

1 (a) Consider the following modification of the EOQ problem. Suppose that demand not filled immediately can be backordered. Let D be annual demand, K the fixed ordering cost, h inventory holding cost per unit per time, and b the backorder cost per unit per time.

(i) Draw the sawtooth diagram. State all your modelling assumptions. [10%]

(ii) Write the total cost function. [15%]

(iii) Find the optimal order quantity. [15%]

(iv) Find the optimal reorder point. [10%]

(v) Discuss how the reorder point changes as b increases. [10%]

(b) Consider the Input-Transformation-Output (ITO) model of Operations Management.

(i) Describe the ITO model. [10%]

(ii) Provide examples of different types of transformation activities. [10%]

(iii) Describe how various transformation activities are connected to each other. [10%]

(iv) Discuss the functions of the management system in this model. [10%]

2 (a) The production manager of W&M, a manufacturer of widgets, has developed the following chart that breaks down their production process into twelve operations, and provides the immediate predecessors of each operation and each operation time in minutes.

Operation	Immediate Predecessors	Operation Time (mins.)
1	None	5
2	1	3
3	2	4
4	1	3
5	4	6
6	3, 5	5
7	6	2
8	7	6
9	6	1
10	6	4
11	10	4
12	8, 9, 11	7

The production manager has heard about the ranked positional weights technique (RPWT) and would like to use it to balance the production line. RPWT works as follows: (1) The positional weight of a task is the cumulative assembly time associated with the task itself and its successors. (2) The tasks are sorted based on their positional weights in a decreasing order. (3) Tasks are assigned in this order to the lowest numbered feasible workstation, keeping the precedence relationships in mind.
The production manager would like to have a cycle time of 10 minutes.

(i) Represent the production manager's problem using a precedence diagram. [10%]

(ii) Use RPWT to achieve a balance with a cycle time of 10 minutes. Show your calculations. What is the balance loss? [20%]

(iii) Is there a solution with a smaller number of stations? Discuss. [10%]

(b) Discuss the limitations of MRP. Describe what is meant by closed-loop MRP and discuss to what extent it addresses the limitations you have identified. [20%]

(c) Explain the *bullwhip effect* in the context of supply chain management. Discuss how its consequences may be reduced. Provide examples as appropriate. [20%]

(d) Discuss the main differences between Lean and Six Sigma, and explain how they complement each other. [20%]

3 (a) Consider a queuing model with two servers, where only three customers are allowed in the system. Customers who arrive and find that there are three customers in the system never return. Assume that the arrival distribution is Poisson with mean λ and the service time of each server is exponentially distributed with mean service rate μ.

(i) Set up the transition diagram, and determine the balance equations. [10%]

(ii) Determine the steady-state probabilities. [15%]

(iii) Determine the average number of customers in the system, the average queue length, the average waiting time in the system, the average waiting time in the queue, and the arrival rate for the customers who are served in the system. [15%]

(b) Define the *theoretical capacity* of a manufacturing facility. Explain why the actual capacity of a manufacturing line is often different from its theoretical capacity. [20%]

(c) Explain what is meant by a *job shop*. Under what circumstances is such an operating approach appropriate? Illustrate your answer using several typical examples. [10%]

(d) Job shop scheduling methods can be used to schedule many types of operations. Give three non-manufacturing examples that could use job shop scheduling. [10%]

(e) Explain the concept of *mass customisation* and discuss the components of effective mass customisation. [20%]

END OF PAPER