Version FE/3

EGT2: IIA
ENGINEERING TRIPOS PART IIA

Friday 4 May 2018 9.30-11.10

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.*

STATIONERY REQUIREMENTS
Single-sided script paper

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
CUED approved calculator allowed

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.

1 (a) Define the concepts of trend and seasonality for a series in relation to forecasting. [10%]

(b) The Winters multiplicative method is being used to forecast quarterly US retail sales (in billions of US dollars). The forecasting equations of the Winters multiplicative method are shown in Equation (1) - Equation (4):

$$E_t = \alpha \frac{X_t}{S_{t-c}} + (1-\alpha)(E_{t-1} + T_{t-1}) \quad (1)$$

$$T_t = \beta(E_t - E_{t-1}) + (1-\beta)T_{t-1} \quad (2)$$

$$S_t = \gamma \frac{X_t}{E_t} + (1-\gamma)S_{t-c} \quad (3)$$

$$F_t(k) = (E_t + kT_t)S_{t+k-c}. \quad (4)$$

At the end of the first quarter of 2017, $E_t = 300$, $T_t = 50$, and the seasonal indices are as follows: quarter 1, 0.90; quarter 2, 0.95; quarter 3, 0.95; quarter 4, 1.20. During the second quarter of 2017, retail sales are USD 380 billion. Assume $\alpha = 0.2$, $\beta = 0.4$, and $\gamma = 0.5$.

(i) Explain the meaning of each equation, Equation (1) - Equation (4). [20%]

(ii) At the end of the second quarter of 2017, develop a forecast for retail sales during the fourth quarter of 2017. [10%]

(iii) At the end of the second quarter of 2017, develop a forecast for retail sales during the second quarter of 2018. [10%]

(c) The product structure for an end item is described below. The number in parentheses indicates the lead time (in weeks) for making or purchasing each item.

End Item:	Composed of 2 units of A, 2 units of B and 3 units of C.
Item A (1 week):	Composed of 2 units of B and 1 unit of D.
Item C (2 weeks):	Composed of 1 unit of B and 2 units of D.

Item B has a lead time of 2 weeks and item D has a lead time of 4 weeks.

(i) Draw the product structure diagram. [10%]

(ii) What is the lead time for making the end item from scratch? [5%]

(iii) Assume the master production schedule (MPS) for the end item from weeks 4 to 10 is as follows:

Week	4	5	6	7	8	9	10
Net Requirement	100	50	100	200	100	50	100

Assume that lot-for-lot scheduling is used throughout. The scheduled receipts for part B in period 2 is 500, in period 4 is 200, in period 6 is 750, and in period 8 is 300. The scheduled receipts for part C in period 4 is 150 and in period 6 is 150. Determine the gross requirements for component B. [25%]

(d) "A JIT system will perform better than an MRP system when demand has a trend and is seasonal." Discuss the validity of this statement. [10%]

2 (a) Indicate whether the following statements are true or false. Provide a brief reason for your answer.

(i) Assume that the demand is deterministic, time-varying, and the variability of demand between periods is high. In such a setting, use of a fixed EOQ, based on the average demand during the planning horizon would be effective. [5%]

(ii) Strategies like everyday low pricing to eliminate forward buying of bulk orders can cause the bullwhip effect. [5%]

(iii) The actual capacity of a system is equal to its theoretical capacity. [5%]

(b) Great Margin (GM) sells 3 toy car models – the Classic, the Sporty, and the Yuppie. The demand for each model is constant and uniform during the year. Production is scheduled using EOQ. The inventory carrying cost for GM is 24% per year. The following information has been obtained for each of the models:

Toy Cars	Cost	Demand	EOQ
Classic	50	100/month	300
Sporty	50	60/month	120
Yuppie	200	20/month	40

(i) From the information given, determine what setup cost is incurred each time a production run begins for each of the three models. [15%]

(ii) Suppose you decided to determine the master schedule for the Yuppie using the lot-for-lot rather than the EOQ system. What is the value of the setup cost for the Yuppie such that the lot-for-lot method would give the optimal schedule? [15%]

(iii) The most expensive component of a toy car is the electronic sound unit. The Classic and Sporty models require one sound unit each. The Yuppie requires two. These units are purchased from a local supplier from whom replenishment is instantaneous with zero lead-time. The inventory of sound units is reviewed monthly. The cost of each unit is £20 and the order cost is £140 each time an order is placed. No shortages are allowed, and there is no inventory currently on hand. Using the least unit cost algorithm, determine the size and the period of placement for the third order. [15%]

(iv) Explain different manufacturing process types based on volume-variety trade off. Provide typical examples of circumstances under which each manufacturing process is suitable. [25%]

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(v) Define Little's Law; and describe its relevance to inventory and production planning. [15%]

3 (a) Describe Ferdows and DeMeyer's Sandcone model. [15%]

(b) Describe the six sigma DMAIC framework. Discuss how it differs from DMADV. [15%]

(c) What are the key capacity decisions one needs to make? Discuss the key challenges for each of these decisions. [15%]

(d) You have received an order from a customer to process six jobs for delivery on the following due dates:

Job	**A**	**B**	**C**	**D**	**E**	**F**
Processing time (days)	2	4	2	1	2	4
Due date (from current day)	6	8	7	4	10	9

Assign the order of jobs to minimise average completion time and explain the rationale for your answer. Calculate the mean flow time and the average lateness. [15%]

(e) Discuss the elements of Toyota Production System (TPS). [20%]

(f) TesComp, one of the largest green computer manufacturers in North America, has asked you to determine its production plan for the next 4 months to minimise the total costs. The following table gives the forecasted demand for the company's product in the planning horizon:

Month	January	February	March	April
Demand	4,200	2,400	6,400	2,500

It takes a worker 30 minutes to produce one unit of the product. TesComp currently employs 10 workers. Each worker works exactly 160 hours per month.

Each worker receives a monthly salary of £3,200. The hiring and firing costs per worker are £1,000 and £1,500, respectively. Workers can be hired and laid off only at the beginning of each month. TesComp does not allow workers to be idle; i.e., production time is either used to fulfil demand or to build up inventory. For each unit of inventory at the end of a month, TesComp pays £1 of inventory holding cost. Neither overtime production nor backlogging demand is allowed.

The company currently has 1,000 units of inventory, and wants to have 1,500 units of inventory at the end of April.

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(i) Determine a production plan using the level strategy. [10%]

(ii) Determine a production plan using the chase strategy. [10%]

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