

SUMMER EXAMINATIONS 2001

PRODUCTION SYSTEMS 1

SECOND YEAR INDUSTRIAL ENGINEERING AND INFORMATION SYSTEMS  
SECOND YEAR MANAGEMENT ENGINEERING WITH LANGUAGE  
VISITING STUDENTS

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**Time allowed: 3 hours** Cambridge Elementary Statistical tables and Graph paper available.  
**Attempt: Any 5 questions.**

- Q1 a)** Explain how an MRP system works using a simple example. (12 marks)
- b) Explain the main performance differences between the JIT Pull system and the MRP Push system. Suggestion: You may use the JIT Laboratory as an example. (8 marks)
- Q2 a)** Discuss the evolution of the concept of quality of manufactured products during the last century. What do you understand by TQM (Total Quality Management)? List in order of importance three (3) pre-requisites for the successful development of a TQM system. (12 marks)
- b) A company which is ISO 9001:1994 certified is well on its way to achieving product quality excellence. Do you agree or disagree?. Why?. (8 marks)
- Q3 a)** Suppose the desired output of a line is 30 units per hour. Why might management consider cycle times other than 120 seconds? (6 marks)
- b) A Company is setting up an assembly line to produce 60 units per hour. The table below identifies the work elements, times, and immediate predecessors.

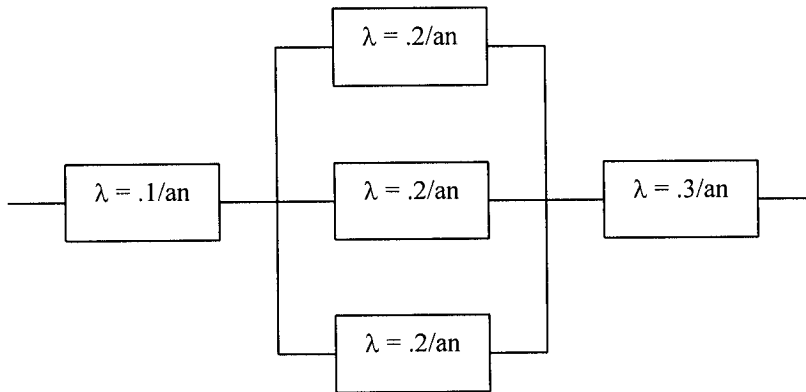
Work element	Time(Sec's)	Immediate Predecessor
1	40	none
2	30	1
3	50	1
4	40	2
5	6	2
6	25	3
7	15	3
8	20	4, 5
9	18	6, 7
10	30	8, 9
Total =	274	

From this information: -

- i) Draw a precedence diagram. (3 marks)
- ii) What is the desired cycle time and the theoretical minimum number of workstations? (2 marks)
- iii) Design a balanced assembly line. (7 marks)
- iv) What is the balance delay? (2 marks)

- Q4 a) Define the reliability of a product or a system. Carefully explain the different elements of the definition. What is the difference between the quality and the reliability of a product? (6 marks)

- b) Determine the reliability of the system as given by the following Reliability Block Diagram (R.B.D.) at  $t = 3$  years:



where each component has exponential life with parameter per annum as indicated in the diagram. (8 marks)

- c) Explain with an example how redundancy (placing units in parallel) increases the reliability of a system. (3 marks)
- d) Define Risk Priority Number (RPN) in the context of Failure Mode Effects/Criticality Analysis. (3 marks)

- Q5 a) Describe the general objectives and the approach you would take in laying out a manufacturing facility. (6 marks)
- b) Describe a product and a process type layout and explain when each would be used in manufacturing. (Sketch each layout type) (8 marks)
- c) Describe and sketch a Cellular Manufacturing System. (6 marks)

- Q6 a) The following data were collected from a machine that cuts pieces of metal to a particular length. Ten random samples were collected, with each sample containing 5 cut pieces. The table contains the mean and range of each sample in meters.

Sample	Mean	Range	Three Sigma Limits
1	14.4	2.1	$\bar{X} \pm A_2 \bar{R}$
2	14.1	3.2	$\bar{X} \pm A_2 \bar{R}$
3	13.6	1.5	$\bar{X} \pm A_2 \bar{R}$
4	13.9	2.5	
5	14.0	1.9	
6	15.1	2.6	$UCL = \bar{X} + D_4 \bar{R}$
7	14.5	0.9	
8	13.9	1.2	$LCL = \bar{X} - D_3 \bar{R}$
9	14.2	2.1	Sample Size 5
10	14.3	3.0	$A_2 = 0.577, D_3 = 0.0$ $D_4 = 2.115$

Develop  $\bar{X}$  and R charts of the Process. Is the Process in control? (14 marks)

b) Explain with examples what you understand by the following terms in the context of Acceptance Sampling Plans:

- (i) Operating Characteristic Curve
- (ii) Producers risk
- (iii) Consumers risk
- (iv) Acceptable Quality Level (AQL)
- (v) Lot Tolerance Percentage Defective (LTPD)
- (vi) Average Outgoing Quality (AOQ)

(6 x 1 marks)

Q7 a) Describe the measurement of Quality Productivity Ratio (QPR). What does the ratio measure?

(4 marks)

b) A Company manufactures motors at a direct cost of £30/unit and rework cost of £12/unit (if necessary). At present, the Company plans to produce 100 motors each day; 80% are good, 50% of the defective units are reworked and are sold as good units.

The Company is interested in 4 possible changes:

1. Increase production to 200 units/day.
2. Cut processing cost to £26 & rework cost to £10, and leave production level at 100/day.
3. Increase yield to 95%, leaving production level at 100/day.
4. Combine 2 & 3.

Determine the QPR for each of these four changes?

(8 marks)

c) Write a short note to the Board of Directors of a Company describing the four major cost categories associated with quality management.

(8 marks)

Q8 a) What are the main stages of the design process.

(6 marks)

b) Suggest some basic guidelines which can be used in design for manufacturing analysis.

(8marks)

c) For the assembly shown below, carry out a Design for Manufacturing (DFM) analysis and suggest and sketch an improved assembly design.

(6 marks)

