[ab52]

UNIVERSITY OF BOLTON

RAK CAMPUS

SCHOOL OF THE BUILT ENVIRONMENT AND ENGINEERING

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER 2 EXAMINATION 2010/2011

MANUFACTURING SYSTEMS & AUTOMATION

MODULE NO: DMT2035

Date: Monday, 6 June 2011 **Time:** 13.00 – 15.00

INSTRUCTIONS TO CANDIDATES:

There are 8 questions in three sections.

Answer 2 questions from each section.

Questions in Section A carry 10 marks each and must both be answered. Questions in Sections B and C carry 20 marks each.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 100 marks.

All working must be shown. A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

A template is provided in Appendix 1, for use with Q6. If you use it, make sure you mark the paper with your student number and include it with your answer book.

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Section A – Answer both questions

1

a) How does the skill range of people or machines in a product layout system compare with that of people or machines in a process layout system? (3 marks)

b) Name and briefly describe **one** situation that would best be served by a fixed-position layout. Give reasons. (3 marks)

c) What advantages does a mixed-model assembly line offer when compared with the traditional single- or multi-model assembly line? (4 marks)

Total 10 marks

2

a) Name, sketch and label **two** physical configurations of industrial robot, relating their Degrees of Freedom to their joint motions and axis relationships. (4 marks)

b) Name and briefly outline any **two** programming methods for programming robots. (4 marks)

c) Name and briefly describe **two** differences between Bluetooth and Wi-Fi technologies. (2 marks)

Total 10 marks

End of Section A

Please turn the page for Section B

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Section B – answer ANY TWO questions

3. a) Outline the essential principles and identify one typical application of each of the following four (4) sensors:

- limit switches
- inductive sensors
- capacitive sensors
- optical detectors

(8 marks)

b) Identify with the aid of simple block diagrams the basic elements of a Computer Numerical Control (CNC) machine. Consider mechanical, power and control elements. Briefly explain their principles and functions within a CNC machine.

(12 marks)

Total 20 marks

———

4. a) Identify and explain three (3) types of data that need to be collected to monitor the manufacturing operations on the workshop floor.

(8 marks)

b) Using simple labelled sketches, briefly describe and explain the following communication techniques for shop-floor and process control:

- serial data communication
- parallel data communication
- discrete and analog I/O with programmable logic control (PLC)
- Fieldbus

(12marks)

Please turn the page for Q5

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5. A manufacturing company is planning to add a new "close-coupled" assembly line, and you have been asked to balance the process, given the following task times and precedence relationships (Table Q5).

Task	Operation Time (Minutes)	~~Precedent(s)~~Precedent(s)
A	0.3	-
B	0.4	A
C	0.2	-
D		B, C
E		D
F		B, E
G		~~E,~~ F
~~H~~	~~0.2~~	~~G~~
~~I~~	~~0.6~~	~~F, H~~
~~J~~	~~0.4~~	~~I~~
~~K~~	~~0.5~~	~~I~~
~~L~~	~~0.7~~	~~J, K~~

~~This page with Erping for simplification of Table Q5~~

Table Q5

The company has an 8-hour workday and a target output of 480 units per day.

(i) Determine the cycle time and the theoretical minimum number of workstations required. (3 marks)

(ii) Draw the precedence diagram for the line. (2 marks)

(iii) Assign tasks to workstations by using the Ranked Positional Weight (RPW) method. (7 marks)

(iv) Calculate the throughput time (flow time), the efficiency of the line and the balancing loss. (3 marks)

(v) Explain in **general** terms how occasional stoppages due to equipment breakdown might affect such a "close-coupled" line, and propose **one** method of accommodating such stoppages. (5 marks)

Total 20 marks

End of Section B

Please turn the page for Section C

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Section C – answer ANY TWO questions

6. (a) For a 2-serial-process operation, Johnson's Rule may be used to determine a feasible and often optimal sequence in which jobs may be released to the system.

Explain in simple words, possibly supported by bullet points and/or a diagram, the **main principles** of Johnson's Rule.

(*NOTE: Do not provide a detailed numerical example here - only a broad outline of the general principle is necessary.)*

(5 marks)

(b) In a production situation, five jobs need to be sequenced through three serial workcentres. The processing times are shown below:

	Workcentres and duration (hours)		
Job Reference	**A**	**B**	**C**
Z	1	3	7
Y	6	4	6
X	3	6	5
W	4	2	3
V	2	3	1

Using a modified version of Johnson's Rule:

i) determine two feasible sequences

ii) determine the makespan for each sequence, and

iii) select the "better" one of the two, with reasons.

Show all your working, and illustrate your results using the Gantt chart on the template provided in Appendix 1.

(15 marks)

Total 20 marks

Please turn the page for Q7

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7. (a) Explain the essential features of – and differences between – the PAYBACK and INTERNAL RATE OF RETURN approaches to appraising investments, and indicate a scenario in manufacturing where each might be used.

(4 marks)

(b) A process engineer has been asked to investigate a technician's request to buy a specialised assembly fixture to improve process yield on an assembly line. The fixture has an estimated cost of €23,000, and the engineer estimates that the fixture will produce time savings that can be valued at €450 per week.

If you were the process engineer, would you support the technician's request, or would you not? Why?

(2 marks)

(c) An operations director is considering a significant expansion to a diecasting shop, involving buildings and machinery. There is a 5-year plan for the expansion, and the company's financial director is looking for the project to show a Net Present Value of at least €1.5million over that period.

Based on best estimates, the extension will cost €5million to buy and install, and will contribute a steady €2.8million per year to net income.

Because of an anticipated upturn in the market for the company's products, and a potential recent improvement in world trading conditions, the financial director is unusually fond of risk, so is willing to consider a relatively aggressive Discount Rate.

Under these conditions, is the investment likely to get the go-ahead?

Explain your reasoning, and indicate why you chose the Discount Rate that you did.

Refer to Table Q7c below for Discount Factors at 10%, 20% and 30%.

(14 marks)

Total 20 marks

Question 7 continued over

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Question 7 continued

5-year Discount Factor Table

	Discount Rate		
Year	**10%**	**20%**	**30%**
0	1.0000	1.0000	1.0000
1	0.9091	0.8333	0.7692
2	0.8264	0.6944	0.5917
3	0.7513	0.5787	0.4552
4	0.6830	0.4823	0.3501
5	0.6209	0.4019	0.2693

Table Q7c – Discount factors at different discount rates and future years

_____

8. (a) A manufacturing engineer has been asked to estimate the number of dedicated pieces of equipment needed for a range of electronic products.

There are three product families in the range. Each family has different processing requirements, and each has a different demand (sales) pattern. Initially, it may be assumed that all the products within a family share a common processing sequence.

The manufacturing engineer has data on processing times for products in each family, and there are quarterly sales forecasts for each family over the coming year.

The company has decided to use a cellular approach to organisation, so each family has its own group of equipment. Each cell will need similar pieces of equipment, but because of the differences between products, the number of pieces of equipment of each type will vary from cell to cell.

Put yourself in the position of the manufacturing engineer and refer to tables Q8b later in this question.

Question 8 continued over

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Question 8 continued

CHOOSE ANY ONE CELL *(i.e. PSUs, Keypads or Displays)* and determine, ***FOR THAT CELL ONLY***:

i) the practical minimum number of pieces of equipment of each type, if none is to be overloaded on average over the year and no overtime is allowed.

(12 marks)

ii) the average workload (in minutes) on each piece of equipment in the cell in each quarter

(4 marks)

iii) the realistic number of pieces of equipment of each type, if an average of 35% overtime (increased capacity) is allowed over the 4 quarters.

(2 marks)

At a late stage of the analysis, the engineer is told that the products cannot be guaranteed to share a common processing sequence.

iv) Comment, with reasons, on whether and how this new information would affect the results of the RCCP analysis.

(2 marks)

Total 20 marks

Question 8 continued over

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Question 8 continued

Product family, processing and demand data

Product demand

	Quarterly demand for family, units				
Family	**1**	**2**	**3**	**4**	**Totals**
PSUs	4000	8000	4000	10000	26000
Keypads	15000	18000	20000	25000	78000
Displays	8000	12000	16000	20000	56000

Product processing times

	Processing time, minutes per unit		
Family	**Screen**	**Solder**	**Auto place**
PSUs	2.0	4.0	3.0
Keypads	3.5	0.5	2.0
Displays	3.0	1.0	2.0

Effective Equipment Capacities (Minutes per Quarter)

Equipment	**Nominal quarterly capacity per unit of resource**
Screen	38400
Solder	33600
Auto place	27000

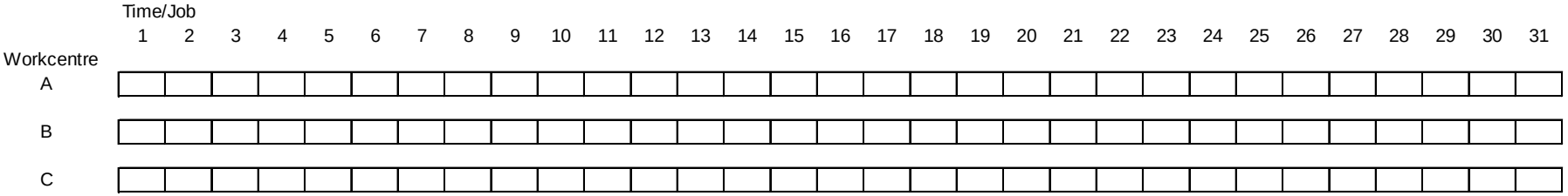
Table Q8b – Demand, processing and workcentre data

END OF QUESTIONS

Please see attached template (Appendix 1) for answer to Q6c

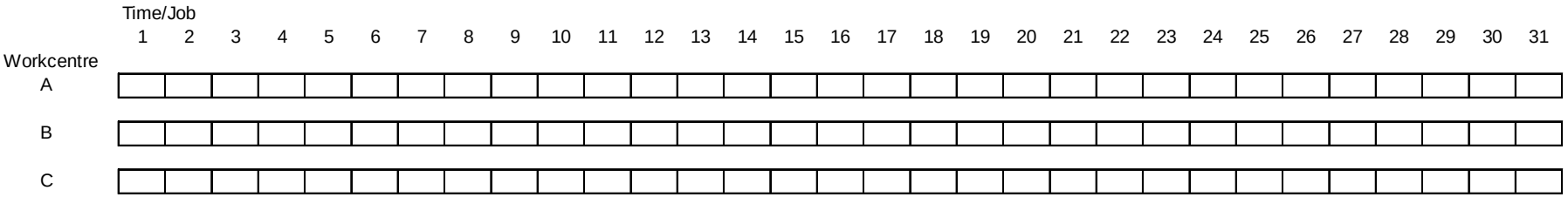
Appendix 1 – Template for Gantt Chart – Q6c

Iteration 1: Gantt chart for sequence 1: ___ ___ ___ ___ ___



MAKESPAN: _____

Iteration 2: Gantt chart for sequence 2: ___ ___ ___ ___ ___



MAKESPAN: _____

***DON'T FORGET!* –** Student ID _____