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UNIVERSITY OF BOLTON

SCHOOL OF THE BUILT ENVIRONMENT AND ENGINEERING

RAK CAMPUS

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER 2 EXAMINATION 2009/2010

MANUFACTURING SYSTEMS & AUTOMATION

MODULE NO: DMT2035

Date: Monday, 7 June 2010 **Time:** 1.00 – 3.00 p.m.

INSTRUCTIONS TO CANDIDATES:

There are 6 questions in two sections.

Answer any 2 questions from each section.

All questions carry equal marks.

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.

If you choose to answer Q6c, you are advised to use the Gantt chart template provided, to mark it clearly with your Student ID and submit it with your answer book.

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SECTION A – Answer any TWO questions from this section.

1. (a) Briefly explain the following production layouts and suggest the applications for each of them:

- Fixed-position layout
- Process layout
- Product layout

(6 marks)

(b) As part of a major plant new project, the manufacturing system designer has been asked to balance a revised assembly operation to achieve an output of 320 units per eight-hour day. Task times and predecessor relationships are as follows:

Task	Operation Time (minutes)	Predecessors
A	1.1	-
B	0.4	A
C	0.2	-
D	0.8	B, C
E	1.2	D
F	1.2	B
G	1.0	E, F

Table Q1 (b) – Operation and precedence data

- Determine the cycle ('Takt') time and the theoretical minimum number of workstations. (3 marks)
- Construct the precedence diagram and assign operations to each workstation using the Ranked Positional Weight (Helgeson-Birnie) method. (10 marks)
- Calculate the throughput time (flow time), the efficiency of the line and the balancing loss. (3 marks)
- Comment on the design of this production line and provide suggestion to improve it. (3 marks)

(Total 25 marks)

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2. (a) List and explain 5 factors that you would take into account when determining sensing technologies to use in a specific manufacturing application. (5 marks)

(b) A toy company is producing a racing car model. The production line involves the processes of: plastic mould arriving, spray painting, metal logo fixing, and dimensional quality control.

You are asked to select sensors to detect the following:

- the arrival of a plastic moulding
- the presence on the model of paint of the correct colour
- the correct presence, orientation and position of the metal logo
- the value of ONE linear dimension for quality control

Use your answer to part a) above to select and justify your recommendation for each sensor selected. (20 marks)

(Total 25 marks)

3. **(**a) Identify and explain THREE similarities and THREE differences between industrial robot systems, CNC machines and Automated Guided Vehicle (AGV) systems, having regard to their major functions, physical scope and attributes, and their applications in manufacturing systems and automation. (12 marks)

(b) Explain why data communication technology plays an important part in field of manufacturing systems and automation. (5 marks)

(c) Using simple sketches where appropriate, explain the following data communication methods:

- Serial data communication
- Parallel data communication
- Bluetooth
- Wi-Fi (8 marks)

(Total 25 marks)

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SECTION B – Answer any TWO questions from this section.

4 (a) With the aid of a suitable diagram, outline the principal stages in the process of planning and operating a manufacturing system, from the initial point of forecasting sales demand to daily operational control.

For each stage in the process, identify the appropriate sources of data needed and show how the data is used.

Outline the essential steps in at least ONE of the stages.

(10 marks)

(b) As a manufacturing engineer, you have been asked to determine the capacity requirements for one year's production of a simple product.

You have been given the following data (Tables Q4b):

Demand Data - Products per Quarter

Quarter				Annual
1	2	3	4	Total
2000	1250	2500	2250	8000

Product-process data

Resource	Work Content (hours per product)
Saw	1
Weld	4
Prep & Paint	2

Resource Data

Resource	Nominal capacity (hours per quarter per unit of resource)	Efficiency
Saw	500	75%
Weld	600	90%
Prep & Paint	450	50%

Tables Q4b – Sales, product, process and resource data

Using the data from Tables Q4b, determine the practical number of units of resource of each type in EACH quarter of the planning year, along with expected percentage loading. Highlight any potential problems, and show your working as clearly as possible.

(15 marks)

Total 25 marks

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5. (a) Explain the PRINCIPAL features of – and differences between – the PAYBACK and INTERNAL RATE OF RETURN approaches to appraising investments, and suggest one manufacturing situation where each might be used.

(6 marks)

(b) A manufacturing engineer has determined that an alignment fixture will speed up production by allowing operators to more easily and accurately set a gap. The fixture's estimated cost is £50,000, and the engineer estimates that the fixture will produce time savings that can be valued at £2500 per week.

Prepare a SIMPLE financial case for the purchase of the fixture. Indicate what method you would use, and show what factors other than time savings you might take into account.

(4 marks)

(c) A medium-sized business is looking to expand its fabrication shop. There is a 7-year plan for the expansion, and the company is looking for a Net Present Value of at least £300,000 at the end of that time.

Based on best estimates, initial investment in changes to the fabrication shop will cost £1,500,000 at the outset. It is hoped that they will bring in an additional £600,000 per year in net sales value. Forecasts are for a tricky economic future, so the financial director is expecting an appropriate Discount Rate.

Is the investment likely to get the go-ahead? Use Table Q5c as necessary, and explain your answer.

HINT – Develop a table in which you show annual discounted cash flows.

(15 marks)

	Discount Factors		
	Optimistic	Likely	Pessimistic
Yr	15%	20%	25%
0	1.0000	1.0000	1.0000
1	0.8696	0.8333	0.8000
2	0.7561	0.6944	0.6400
3	0.6575	0.5787	0.5120
4	0.5718	0.4823	0.4096
5	0.4972	0.4019	0.3277
6	0.4323	0.3349	0.2621
7	0.3759	0.2791	0.2097

Table Q5c – Discount factors at different discount rates and over different project lifetimes

Total 25 marks

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6. (a) Outline ONE key difference between a **jobshop** and a **flowshop**, and indicate ONE typical scheduling objective that might be observed in each case.

(4 marks)

(b) What is meant in general by the term "a heuristic rule"? In the context of manufacturing scheduling, select ONE commonly-used heuristic rule, indicate where it might be used, and explain its principal features, applying it in a particular case using your own data.

(6 marks)

(c) Table Q6c shows data for a static set of FIVE jobs. Each job requires processing on three machines, in the same sequence. Using the "***Campbell & Dudek's extension to Johnson's Rule" heuristic***, find the minimum makespan for the set of jobs, and thereby identify a "best" launch sequence.

What is the **total idle time** for all three machines that results from this "best" sequence?

Describe your method and clearly show your working. You are advised to use the Gantt chart template provided. If you do use it then mark it clearly with your Student ID and attach it to your answer book with the tag provided.

(15 marks)

Job	Machine 1 time	Machine 2 time	Machine 3 time
A	4	6	2
B	2	5	3
C	7	3	6
D	2	2	5
E	3	2	6

Table Q6c – Data for a 5-job, 3-machine flowshop problem.
(All times are in hours)

END OF QUESTIONS

A Gantt chart template for the solution to Question 6c follows on the next page

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Sequence 1: Launch sequence - ___ ___ ___ ___ ___ ___

Time (hr)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Machine 1																																								
Machine 2																																								
Machine 3																																								

MAKESPAN: ____ hrs **TOTAL IDLE TIME:** ____ hrs

Sequence 2: Launch sequence - ___ ___ ___ ___ ___ ___

Time (hr)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Machine 1																																								
Machine 2																																								
Machine 3																																								

MAKESPAN: ____ hrs **TOTAL IDLE TIME:** ____ hrs

APPENDIX: Gantt chart template for manufacturing sequences **Student ID number:** _____