

UNIVERSITY OF BOLTON

**SCHOOL OF THE BUILT ENVIRONMENT AND
ENGINEERING**

BENG (HONS) MECHANICAL ENGINEERING

SEMESTER 1 EXAMINATION 2009/2010

MANUFACTURING SYSTEMS & AUTOMATION

MODULE NO: DMT2035G

GERMAN STUDENTS

Date: **Monday, 20 January 2010**

Time: **10.00 a.m. – 12.00 noon**

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 answer Question 6, be sure to identify Appendix Q6(b) with your Student ID and hand in the completed chart with your answer book.

School of the Built Environment & Engineering
BEng (Hons) Mechanical Engineering
Semester 1 Examination 2009/2010
Manufacturing Systems & Automation
Module No. DMT2035G
German Students

SECTION 1 – Answer any TWO questions

1. (a) Explain why sensors and sensor systems play an important part in field of manufacturing systems and automation. (5 marks)

- (b) The company TesWater produces plastic bottles of drinking water for a range of retail outlets.

The bottle filling production line involves the processes of: empty bottles arriving, water filling, cap fitting & sealing, and label fixing.

As a manufacturing system design engineer, you are asked to select sensors to detect the presence of the following objects:

- an empty bottle
- the level of the water in the bottle
- a metallic screw cap
- a shiny label, and
- an operator's hand entering the workspace

Make and justify a recommendation for each sensor selected, based on its principles of operation.

(20 marks)

Total 25 marks

2. (a) The ST R17 5-axis robot is a general purpose robot arm. It can be programmed by a PC which is connected to the robot's controller.

The controller can also connect to, interface with and control various sensors and equipment through its digital and analogue I/O, RS232 and USB ports, etc.

Identify and explain suitable communication techniques for the following:

- a PC with the Robot controller
- an external mechanical switch sensor to the robot controller, and
- an analogue colour sensor to the robot controller

(9 marks)

Question 2 continued over

School of the Built Environment & Engineering
 BEng (Hons) Mechanical Engineering
 Semester 1 Examination 2009/2010
 Manufacturing Systems & Automation
 Module No. DMT2035G
 German Students

Question 2 continued

- (b) The company producing the R17 robot is planning to add a wireless communication capability into its robots. Identify two established wireless communication techniques for the company, and briefly outline their strengths and weaknesses for this application. (8 marks)
- (c) Compare and contrast robotic systems and CNC machine tools/machining centres, having regard to their major functions, features and applications in manufacturing systems. (8 marks)

Total 25 marks

3. (a) Explain the importance of the production layout planning in a manufacturing organisation. Identify Three types of layouts used in the manufacturing systems, and give One example for each layout explained above. (6 marks)
- (b) The ToyTech company have obtained a contract to produce a toy – a racing car model. The company wish to design a production line to make the model as efficiently as possible.

The manufacturing processes involved in the racing car model, task times and precedence relationships are shown in Table Q3(b). The requirement from the Master Production Schedule is to produce 60 models per hour.

Operation	Length (minutes)	Preceding Operation(s)
A - Mould	0.8	-
B - Spray-paint	0.5	A
C - Add Logo	0.2	B
D – Solder	0.6	-
E – Assemble	0.3	C, D
F – Decorate	0.7	E
G - Quality Control	0.5	E, F
H – Pack	0.4	G
I - Ship	0.6	H

Table Q3(b) – Data for Flowline Analysis

Question 3 continued over

School of the Built Environment & Engineering
BEng (Hons) Mechanical Engineering
Semester 1 Examination 2009/2010
Manufacturing Systems & Automation
Module No. DMT2035G
German Students

Question 3 continued

- Determine the cycle ('takt') time and the theoretical minimum number of workstations. (2 marks)
- Construct the precedence diagram and assign operations to each workstation using the Ranked Positional Weight (Helgeson-Birnie) method. (6 marks)
- Calculate the throughput time (flow time), the efficiency of the line and the balancing loss. (2 marks)
- Each workstation has a reliability of 0.95 which means that on average, five out of every hundred pieces passing through a workstation cause that workstation to jam. A jammed workstation requires maintenance that takes 3 minutes, and stops the whole line for that time.

Calculate the average effective production rate of the line and the percentage down time. (6 marks)
- Comment on the design of this production line and provide suggestion to improve it. (3 marks)

Total (25 marks)

END OF SECTION 1

SECTION 2 FOLLOWS ON THE NEXT PAGE

School of the Built Environment & Engineering
BEng (Hons) Mechanical Engineering
Semester 1 Examination 2009/2010
Manufacturing Systems & Automation
Module No. DMT2035G
German Students

SECTION 2 – Answer any TWO questions

4. (a) Explain what is meant by the term “RCCP”.
(5 marks)
- (b) With the aid of a diagram, show the relationship between RCCP, financial appraisal and operational scheduling.
(8 marks)
- (c) Use data of your own to create a fluctuating forecast of sales for three months, for two products that each require processing on the same two machines.

Create also a small static data set (table) that describes the processing required by each product at each machine

From this forecast, draw up a three-month load prediction for each of the machines.

(12 marks)

Total 25 marks

5. (a) Why is it important that a Manufacturing Engineer should understand the basic principles of Financial Appraisal?
(5 marks)
- (b) A manufacturing company is comparing two different investment strategies: automation of one of its European facilities against outsourcing from Vietnam. It is looking to determine the Net Present Value of each project over 5 years using a Discount Rate of 20%

The data for each strategy is presented in Table Q5(b).

Given this data, and looking purely from a financial viewpoint, which strategy would you recommend and why?

Question 5 continued over

School of the Built Environment & Engineering
 BEng (Hons) Mechanical Engineering
 Semester 1 Examination 2009/2010
 Manufacturing Systems & Automation
 Module No. DMT2035G
 German Students

Question 5 continued

Europe			
Year	Fixed Costs	Variable Costs	Income
0	250,000		
1		10,000	100,000
2		10,000	100,000
3		10,000	100,000
4		10,000	100,000
5		10,000	100,000
Vietnam			
Year	Fixed Costs	Variable Costs	Income
0	250,000		
1		5,000	100,000
2		7,000	100,000
3		9,000	100,000
4		12,500	100,000
5		16,500	100,000

Table Q5(b) – Data for Financial Appraisal

(12 marks)

- (c) On the basis of your analysis in Q5(b) over 5 years, would your recommendation over 10 years be the same? Give qualitative reasons.

(8 marks)

Total 25 marks

Please turn the page

School of the Built Environment & Engineering
 BEng (Hons) Mechanical Engineering
 Semester 1 Examination 2009/2010
 Manufacturing Systems & Automation
 Module No. DMT2035G
 German Students

6. (a) What do you understand by the term “scheduling”, and how does it differ from (and relate to) “sequencing”?
 (4 marks)
- (b) In BROAD OUTLINE ONLY, explain the key points of Johnson’s Rule, showing specifically the context in which it is useful.
 (6 marks)
- (c) In the data set shown in Table Q6(c), four jobs have arrived at a single workcentre and are waiting for an earlier job to finish being processed.

Job	Processing Time (days)	Due Date (days from now)
A	2	5
B	4	3
C	6	2
D	1	7

Table Q6(c) – data for 1-machine, 4-job sequencing scenario

Describe the key points of the “EDD” and “SPT” heuristics, and apply them to determine the sequence in which the jobs might be selected once the workcentre becomes free.

Using the Gantt charts in Appendix Q6(b), for each sequence, determine:

- The Maximum Lateness
- The Average Lateness
- The number of Tardy jobs

(13 marks)

- (d) On the basis of your analysis in (c) above, which sequence would you recommend if your objective was to minimise the number of tardy jobs?
 (2 marks)

Total 25 marks

END OF QUESTIONS – APPENDIX Q6(b) FOLLOWS

School of the Built Environment & Engineering
 BEng (Hons) Mechanical Engineering
 Semester 1 Examination 2009/2010
 Manufacturing Systems & Automation
 Module No. DMT2035G
 German Students

	Days >																			
Jobs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

	Days >																			
Jobs	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Student ID number: _____