

**UNIVERSITY OF BOLTON**

**FACULTY OF ADVANCED ENGINEERING  
AND SCIENCES**

**BENG (HONS) MECHANICAL ENGINEERING**

**GERMAN COHORT**

**SEMESTER 1 EXAMINATION 2011/2012**

**MANUFACTURING SYSTEMS & AUTOMATION**

**MODULE NO: DMT2035G**

Date: **Wednesday, 18 January 2012**

Time: **10.00 a.m. – 12.00 noon**

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**INSTRUCTIONS TO CANDIDATES:**

This examination paper carries a total of **100** marks.

Answer **ALL** questions.

Marks for parts of questions are shown in brackets.

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 Q2. If you use it, make sure you mark the paper with your student number and ATTACH it to your answer book.

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Manufacturing Systems & Automation  
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1. a) Using an appropriate diagram, show the relationship between the following elements in a manufacturing system control hierarchy. Arrange the items in a top-down way, showing clearly the flow of data.

- Added-value product output
- Sensors
- Senior strategic management decisions
- Physical operation of the manufacturing process(es)
- Low-level logic control decisions
- Tactical management planning
- Actuators
- Activity scheduling and production planning
- Material input

(10 marks)

b) Draw a relay-ladder diagram for a PLC program that meets the following specification:

- When a "START" button is pressed, a GREEN LIGHT illuminates and latches on.
- When a "STOP" button is pressed, the latch is reset and the green light goes out.
- While the green light is on, TIMER 1 runs down from 5 seconds.
- When TIMER 1 reaches zero, TIMER 2 runs down from 10 seconds.
- While TIMER 2 is running, a CONVEYOR runs and a RED LIGHT is illuminated.
- Pressing the STOP button resets both Timers.

(10 marks)

c) Express the same program in LOGIC STATEMENT terms (for example, IF <input> OR <input> AND NOT <input> THEN <output>).

(5 marks)

**Total 25 marks**

**Please turn the page**

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2. (a) For a 2-serial-process flowshop with a set of jobs to be launched, Johnson's Rule may be used to determine a feasible launch sequence, thereby minimising the makespan of the job set.

Explain in simple words and with a step-by-step example involving FOUR jobs with your own data, the **main principles** of Johnson's Rule, including an explanation of why it tends to give good results.

(10 marks)

- (b) In a production situation, a set of FOUR jobs need to be sequenced through THREE serial workcentres. The processing times are shown below:

Job Reference	Workcentre and duration (hours)		
	A	B	C
Z	1	3	5
Y	5	3	2
X	3	4	1
W	2	1	5

Using the "Campbell and Johnson" extension to Johnson's Rule:

- i) determine two sequences likely to give optimal makespan (5 marks)
- ii) use a Gantt chart to determine the makespan for each sequence (5 marks)
- iii) select the "better" sequence, and explain your choice. (5 marks)

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

**Total 25 marks**

**Please turn the page**

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3. (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**

4. (a) Explain the essential features of – and major differences between – the PAYBACK and NET PRESENT VALUE methods of appraising investments, and indicate a manufacturing scenario 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 USD 25,000, and the engineer estimates that the fixture will produce time savings that can be valued at USD 250 per week.
- If you were the process engineer, would you support the technician’s request, or would you not? Give a simple calculation to support your decision. (3 marks)

**Question 4 continued overleaf**

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**Question 4 continued**

- (c) An Operations Director is considering a significant expansion to a press shop, involving buildings and machinery. There is a 6-year plan for the expansion, and the company's financial director insists that the project should show a Net Present Value of at least £2million over that period in order that it should be approved.

Based on best estimates, the expansion will cost £7million to buy and install, and will contribute a steady £3.5million per year to net income.

Corporate policy requires that investments show a high degree of "insulation" from financial turbulence. Appropriate Discount Rates are therefore expected in financial appraisals.

- i. **Outline** the method by which you might set about performing the appraisal for the Operations Director. (10 marks)
- ii. Using this method, estimate the amount by which the predicted NPV will exceed or fall short of the target. (8 marks)

Refer to Table Q4c over the page for a range of discount factors. Select and use ONE discount rate as appropriate.

**Total 25 marks**

**6-year Discount Factor Table**

Year	Discount Rate		
	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
6	0.5645	0.3349	0.2072

**Table Q4c – Discount factors at different discount rates and future years**

**END OF QUESTIONS**

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Please see attached template (Appendix 1) for answer to Q2b

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**Appendix 1 – Template for Gantt Chart – Q2b**

**Iteration 1: Gantt chart for sequence 1:** \_\_\_\_\_

Workcentre	Time/Job																															
	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	
A																																
B																																
C																																

**MAKESPAN:** \_\_\_\_\_

**Iteration 2: Gantt chart for sequence 2:** \_\_\_\_\_

Workcentre	Time/Job																															
	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	
A																																
B																																
C																																

**MAKESPAN:** \_\_\_\_\_

***DON'T FORGET!*** – Student ID \_\_\_\_\_