## NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

## DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

Bachelor of Engineering Honours Degree Industrial \& Manufacturing Engineering
Manufacturing Systems - TIE 3212

## SUPPLEMENTARY EXAMINATIONS OCTOBER 2009

Time allowed: 3 hours
Instructions: Answer ANY FOUR (4) questions from Section A and The question in Section B

## QUESTION 1

Table 1 illustrates a machine/part matrix for a toy manufacturing plant. Use the similarity coefficients method to develop natural manufacturing cells.
Table 1 Machine- Part Matrix

|  | Part |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Machine | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |  |
| A | 1 | 1 | 1 |  | 1 | 1 | 1 |  |  |
| B |  | 1 | 1 | 1 | 1 |  |  | 1 |  |
| C |  | 1 | 1 |  | 1 |  |  | 1 |  |
| D | 1 |  | 1 | 1 |  | 1 | 1 |  |  |

(b) Give three benefits of cell based manufacturing over the traditional approaches?

## QUESTION 2

Table 2.1 shows the machine-part matrix for a specific job shop. You are required to form manufacturing cells with the aid of Binary ordering Algorithm.
Table 2.1: Part/Machine matrix

|  | Part |  |  |  |  |  |  |  |
| :---: | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Machine | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| A | 1 | 1 |  |  | 1 |  |  |  |
| B |  |  | 1 |  |  |  |  | 1 |
| C |  | 1 | 1 |  |  | 1 | 1 |  |
| D |  |  |  | 1 |  |  |  | 1 |
| E |  |  | 1 | 1 |  | 1 | 1 |  |
| F |  |  |  |  |  |  |  |  |
| G | 1 | 1 |  |  | 1 |  |  |  |

## QUESTION 3

a) Given eight jobs to be produced on a single milling machine with data shown in Table 3.1

Table 3.1: Processing time and Due dates

| Job I | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Processing <br> time $\mathrm{p}_{\mathrm{I}}$ | 10 | 9 | 2 | 24 | 13 | 1 | 3 | 5 |
| ${\text { Due Date } \mathrm{d}_{\mathrm{i}}}$ | 40 | 34 | 8 | 12 | 65 | 42 | 29 | 51 |

i) Schedule the lathe to minimise average flow time
ii) Find the average flow time and maximum tardiness for the schedule obtained in (i)
iii) Schedule the lathe to minimise maximum tardiness
iv) Find the average flow time and maximum tardiness for the schedule obtained in (ii)
b) Given that the processing times for the jobs given in Table 3.1 on the polishing machine is as shown in Table 3.2

Table 3.2: Processing time on Polishing machine

| Job | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| Processing <br> time | 13 | 2.5 | 2 | 8 | 12 | 10 | 2.8 | 9 |

i) Using Johnson's Algorithm find the sequence for the jobs in the whole Plant (milling and polishing machine) with an aim to minimizing makes span
ii) Find the make span of the jobs for sequence $\{1,2,3,4,5,6,7,8\}$

## QUESTION 4

Consider the set of jobs and processing times shown in Table 4.1
(a) Generate the schedule assuming jobs are processed in the order $\{2,4,1,3$ ). Calculate the make span for this sequence.
(b) Is this the best make span for the jobs? Justify using some calculations

Table 4.1: Flowshop Processing times

| Job | Machine |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
|  | 1 | 2 | 3 | 4 |
| 1 | 2.0 | 3.5 | 1.5 | 2.0 |
| 2 | 4.5 | 3.0 | 2.5 | 1.0 |
| 3 | 1.5 | 1.5 | 5.0 | 0.5 |
| 4 | 4.0 | 1.0 | 2.5 | 0.5 |

## QUESTION 5

Current time is 10 . Machine B has just finished a job and it is time to select its next job. Table 5.1 provides information on the four jobs available. For each of the dispatching rules, determine the corresponding sequence.
(a) SPT
(b) RANDOM
(c) EDD
(d) LTWR
(e) LTWK
(f) MOPNR
(g) MWKR
(h) WINQ
(i) MWKR
(j) $\mathrm{S} / \mathrm{RO}$

Table 5.1: Available Milling jobs

| Job | Arrival to System | Arrival at B | Due Date | Operation (machine, $\mathrm{p}_{\mathrm{ij}}$ ) |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  | 1 | 2 | 3 |
| 1 | 10 | 10 | 30 | $(\mathrm{B}, 5)$ | $(\mathrm{A}, 1)$ | (D,6) |
| 2 | 0 | 5 | 20 | $(\mathrm{A}, 5)$ | $(\mathrm{B}, 3)$ | (C,2) |
| 3 | 0 | 9 | 10 | $(\mathrm{C}, 3)$ | ( $\mathrm{D}, 2)$ | $(\mathrm{B}, 2)$ |
| 4 | 0 | 8 | 25 | $(\mathrm{E}, 6)$ | $(\mathrm{B}, 4)$ | $(\mathrm{C}, 4)$ |

## QUESTION 6

(a) Describe the following terms used in Group technology:
(i) Design attributes
(ii) Part Manufacturing features
(b) Explain five structural issues considered in cell design.
(c) A part design is shown in Figure 6.1 below. Develop a form code using the Optiz system. [5]
(d) Describe the family of parts with an Optiz form code of 53213


Figure 6.1

## SECTION B

## QUESTION 7

(a) Outline three tangible and three intangible benefits of implementing Group Technology. [6]
(b) Give three differences between the monocode and the polycode coding systems.
(c) Consider the parts summarized in Table 7.1. The shop is a flow shop.
(i) Find a lower bound on make span
(ii) Generate a permutation schedule using Campbell's procedure

Table 7.1 : Flow shop processing times

|  | Machine |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| Job | A | B | C | D |
| 1 | 2 | 5 | 1 | 4 |
| 2 | 9 | 11 | 4 | 2 |
| 3 | 8 | 3 | 1 | 6 |
| 4 | 2 | 2 | 3 | 4 |
| 5 | 1 | 5 | 7 | 1 |

