NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL ENGINEERING

MANUFACTURING SYSTEMS IV – TIE 5202

2nd SEMESTER EXAMINATIONS APRIL/MAY 2000

Time Allowed: 3 Hours

Instructions: Answer FIVE (5) questions in all.
Attempt AT LEAST ONE (1) question from each section.
All questions carry equal marks.

SECTION A: NEW MANUFACTURING STRATEGIES

Qu. 1 a) Briefly describe how the goals of just-in-time (JIT) impact on fast-to-marketing of a product. [4]

b) A company is currently having a job shop manufacturing system and uses material requirement planning (MRP) for operations planning. Briefly discuss what major issues to address if the company intends to adopt just-in-time manufacturing strategy. [4]

c) Explain why it is important to level the assembly schedule in JIT. Why is this not so important in MRP? [4]

d) A vehicle assembly plant makes station wagons, convertibles, four-door sedans, and two-door sedans. Market demand for the next 20 production days is expected to be 200, 600, 600 and 400 for station wagons, convertibles, four-door sedans, and two-door sedans respectively.

i) Develop a mixed-model sequence that will level the assembly schedule and satisfy daily demand. [4]
ii) Calculate cycle time per unit and the average cycle time for each model if the assembly plant runs 8 hours each day. [4]

Qu. 2 a) Discuss the driving forces that have impacted on intelligent manufacturing in the late 20th century and beyond. [5]

b) What roles do intelligent optimisation techniques play in intelligent manufacturing? [5]

c) Briefly outline at least five goals of computer integrated manufacturing (CIM). [5]

d) Outline four issues that complicate the analysis of the justification for CIM. [5]

SECTION B: GENERIC MODELLING APPROACH: OPEN NETWORKS

Qu. 3 a) What is meant by steady-state in queuing models? Discuss what conclusions can and cannot be made from steady-state results. [6]

b) A flexible assembly system has five workstations. Order arrivals are a Poisson process with mean rate of 12 per hour. Service time is exponential with a rate of 120 per hour per workstation. In fact, the computer scheduling system maintains a one-hour supply of orders in queue at all times in front of the first workstation. Each time orders arrive at workstations 3, 4, and 5 they fail with a probability 0.1 and are returned to workstation 2. Each time orders arrive at workstation 4 they fail with a probability 0.2 and are returned to workstation 3, while each time orders arrive at workstation 5 they fail with a probability 0.2 and are returned to workstations 3 and 4.

i) Determine the throughput of the assembly system. [9]

ii) Determine the expected number of jobs in the assembly system. [5]

Qu. 4 a) How does the consideration of work-in-process differ in closed networks and open networks? [5]

b) A factory has five machine types A, B, C, D, and E respectively. Four product types are made according to Table Qu. 4. Machine types A, B, and C run 40 hours per week, while machine types D and E run 60 hours per week. Four, five, three, two and three machines of types A, B, C, D and E respectively exist. Using the open network of queues model, determine:

i) the average number of jobs in process [7]

ii) the throughput of the manufacturing system [8]

(Hint: You may use Table Qu. 4 – 5 Formulae)

Table Qu. 4: Part data information

Part Family	Weekly Demand	Operation (machine, hour per part) 1	2	3	4
1	6	(A, 5)	(E, 3)	(C, 7)	(D, 1)
2	12	(B, 8)	(D, 6)	(E, 2)	(A, 5)
3	8	(B, 3)	(E, 6)	(C, 4)	(A, 4)
4	10	(A, 2)	(C, 2)	(B, 7)	(D, 3)

Qu. 5 a) A job shop has three machines. Four products are made according to Table Qu. 5a. All three machines run 40 hours per week. Sketch:

i) the part routes for the manufacturing system [5]

ii) the external arrivals and routing probabilities model [5]

Table Qu. 5a: Part routings data

Product Type	Weekly Demand	Operation	Machine	Time (Hours)
1	10	1	1	10
		2	3	5
2	20	1	1	15
		2	3	8
		3	2	4
3	30	1	1	5
		2	3	10
4	10	1	2	5
		2	3	8

b) A three-machine workcell produces four parts. Table Qu. 5b shows demand and processing time. In each operation in the process plan, the data pair represents (machine, job processing times in hours). All machines run 40 hours per week. Three of each machine-type is available. The system is modelled using open queuing network model, and exponential server is assumed.

Evaluate the workcell as an open queuing network. [10]
(Hint: You may use Table Qu. 4-5 Formulae)

Table Qu. 5b: Process plan information

Part	Weekly Demand	Process Plan 1	2	3
1	10	(1, 4)	(2, 4)	(3, 2)
2	5	(2, 6)	(1, 3)	-
3	20	(3, 2)	-	-
4	10	(1, 4)	(3, 2)	-

Table Qu. 4-5 Formulae: M/M/C Queuing Results

	M/M/1	M/M/C
P(o)	$1-\rho$	$\left[\dfrac{(c\rho)^c}{c!(1-\rho)}+\sum_{n=0}^{c-1}\dfrac{(c\rho)^n}{n!}\right]^{-1}$
L_q	$\dfrac{\rho^2}{1-\rho}$	$\dfrac{\rho(c\rho)^c P(0)}{c!(1-\rho)^2}$
L	$\dfrac{\rho}{1-\rho}$	$L_q+\dfrac{\lambda}{\mu}$
W_q	$\dfrac{\rho}{\mu(1-\rho)}$	$\dfrac{(c\rho)^c P(0)}{c!c\mu(1-\rho)^2}$
W	$\dfrac{1}{\mu(1-\rho)}$	$W_q+\dfrac{1}{\mu}$

SECTION C: GENERIC MODELLING APPROACH: CLOSED NETWORKS

Qu. 6 a) What assumptions are made in the mean value analysis (MVA) technique for modelling manufacturing systems? [5]

b) Figure Qu. 6 shows a three-workstation system with a single server at stations 1 and 2 and double servers at station 3. Three part types are produced in the system. Parts are transported between workstations by a material handling system (MHS) that is fast relative to machining operations. Part transfers takes 30 seconds on the average. Each workstation has space for two pallets in input queue and one pallet in process. This is expected to be sufficient storage and excess pallets can always be kept at the storage area. There are seven pallets in the system. Two pallets are assigned to part types 1 and 2 respectively, while the remaining pallets are assigned to part type 3. The MHS is scheduled to reach the original point, load the pallet, travel to the destination, and off-load the pallet. Part type 1 visits stations 2 and 3 before returning to the loading/unloading (L/U) station. Part type 2 visits stations 1 and 3 before returning to L/U. Part type 3 visits stations 1 and 2 before returning to L/U. To load a part from the system and to load a new part onto the same pallet and fixture averages 15 minutes. All production operations on workstation 1, 2, and 3 respectively average 10 minutes. Using the mean value analysis method, determine for the first iteration:

i) queue lengths [3]
ii) throughput times [6]
iii) throughput rates [3]
iv) machine utilisations [3]

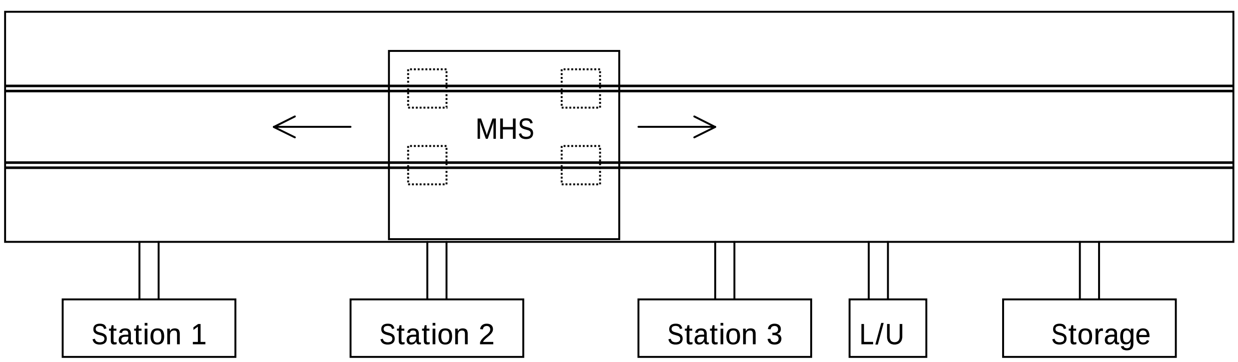
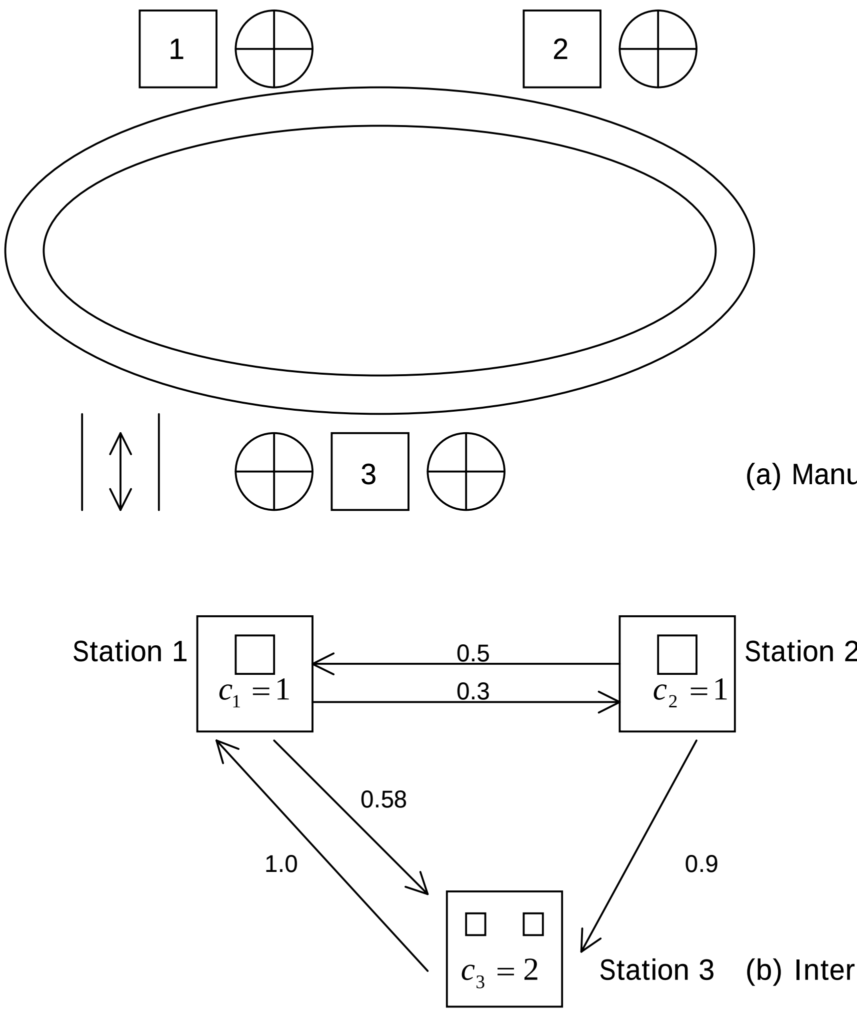


Figure Qu. 6: A flexible manufacturing system for producing part types

Qu. 7 a) How does the product form solution (PFS) model differ from the mean value analysis (MVA)? [5]

b) Figure Qu. 7a shows a three-workstation system with a single server at stations 1 and 2 and double servers at station 3. Parts are transported between workstations by a closed-loop conveyor that connects all machines. The conveyor has ample capacity and small delay time relative to machine processing time so that it can be neglected. The intermachine transfer probabilities are shown in Figure Qu. 7b. Four jobs are kept in process. Server rates are 2 jobs per hour at station 1 and 1 job per hour per server at the other stations. Each job commences at station 1 and returns to station 1 to complete one real-life job before the insertion of another job into the system. Using the product form solution (PFS), determine the average number of jobs. [15]



(a) Manufacturing system

(b) Intermachine transfer probabilities

Figure Qu. 7: System model

END OF EXAM