ISYE 4803-REV: Advanced Manufacturing Systems
Instructor: Spyros Reveliotis
Final Exam
December 14, 2016

Name:

Answer the following questions **(8 points each)**:

1. What is the primary motivation for organizing parts into "families" in cellular manufacturing? What are the typical criteria for establishing these part families?

2. Consider an arrival stream that results from the superposition of n Poisson arrival streams with rates $\lambda_i,\ i = 1, \ldots, n$. The memoryless property of these n streams implies that the probability that the next arrival will occur through the i-th stream, is equal to $p_i = 1/n,\ \forall i$.

(a) YES (b) NO

Please, explain your answer.

3. We applied Moore's algorithm on a set of jobs, and in the returned schedule we have: $(t_{[1]}, d_{[1]}) = (10, 30)$ and $(t_{[4]}, d_{[4]}) = (8, 20)$. Explain that this information implies that the algorithm execution was not correct. (Also, remember that the notation '$[i]$' implies the job in the i-th position of the schedule).

4. We need to schedule five jobs $J_1, \ldots, J_5$ on a **two** identical machines with the corresponding processing times being 30, 50, 70, 40 and 30 minutes. Provide a schedule for these five jobs that will (tend to) maximize the throughput of this operation. Please, represent the developed schedule by means of a Gantt chart.

5. Consider the scheduling problem in Question #4, and further assume that the five jobs have the following "due dates" associated with them: 40, 90, 90, 60 and 30 minutes from the current time. This time, please, provide a schedule that will minimize the maximum tardiness across all these jobs. Again express the developed schedule by means of a Gantt chart.

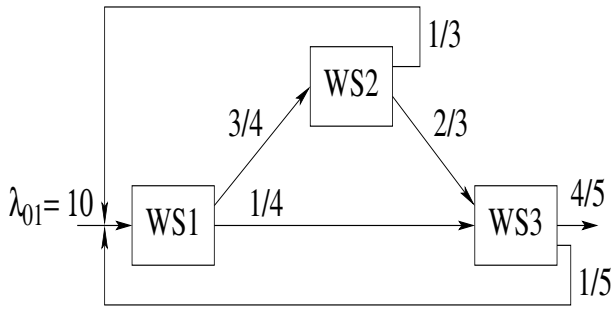
Problem 1 (20 points): A single-server workstation processes parts of two types, A and B. Parts arrive at this workstation as a single stream according to a Poisson process with rate $\lambda = 3$ parts per hour, and they are processed on a FCFS basis. Each arriving part is classified as type A or B with corresponding probabilities 0.6 and 0.4. Processing times for parts of type A have a mean value $\tau_A = 10$ minutes and standard deviation $\sigma_A = 3$ minutes. Processing times for parts of type B have a mean value $\tau_B = 15$ minutes and standard deviation $\sigma_B = 7$ minutes.

i. (10 pts) Show that the operation of this station is stable.

ii. (10 pts) Determine the average cycle time for a part going through this station.

Hint: Try to substitute the two part types mentioned above with a single part type. What should be the mean processing time and the coefficient of variation of this new part type?

Problem 2 (20 points): Consider a manufacturing cell of three workstations, where the arriving jobs circulate among these workstations as indicated in the following figure.



For this cell, please, do the following:

i. (5 pts) Compute the average arrival rate for each workstation.

ii. (5 pts) Assuming that each workstation has only one server, determine the mean processing time for each of these servers so that each workstation has a utilization level of 90%.

iii. (5 pts) What is the departure rate from this cell under the processing times that you computed in part (ii) above?

iv. (5 pts) Compute the expected number of visits at each of the three workstations for each job that goes through this cell.

Problem 3 (20 points): The daily shift at a local shop starts at 8:00am, and at the beginning of today's shift the shop needs to schedule the processing of five jobs $J_1, \ldots, J_5$ with the corresponding processing times being 50, 90, 45, 70 and 100 minutes. Also, today the shop has to go through an one-hour inspection process, and this activity needs to be scheduled during the time interval from 10am to 12pm. Furthermore, there is a lunch break from 12pm to 1pm.

Compute a schedule for the processing of these five jobs that *minimizes the average flow time for these jobs and also observes the additional activities that are mentioned above* (i.e., the inspection process and the lunch break). Please, provide explicitly the start and the completion time for each job, and compute the resulting average completion time. Finally, in your computations assume that the shop inspection and the lunch break will be inserted in the developed schedule according to a *"preempt-resume"* pattern (i.e., the initiation of each of these activities will temporarily stop the running job, and the processing of this job will be continued from where it was stopped, when the interrupting activity is over).