MIT 2.008 Design and Manufacturing II

Spring 2022

Quiz 2 - Part B, Take-Home Component

- All work for CREDIT must be completed in this quiz document
- All work must be completed individually and cannot be discussed with classmates.

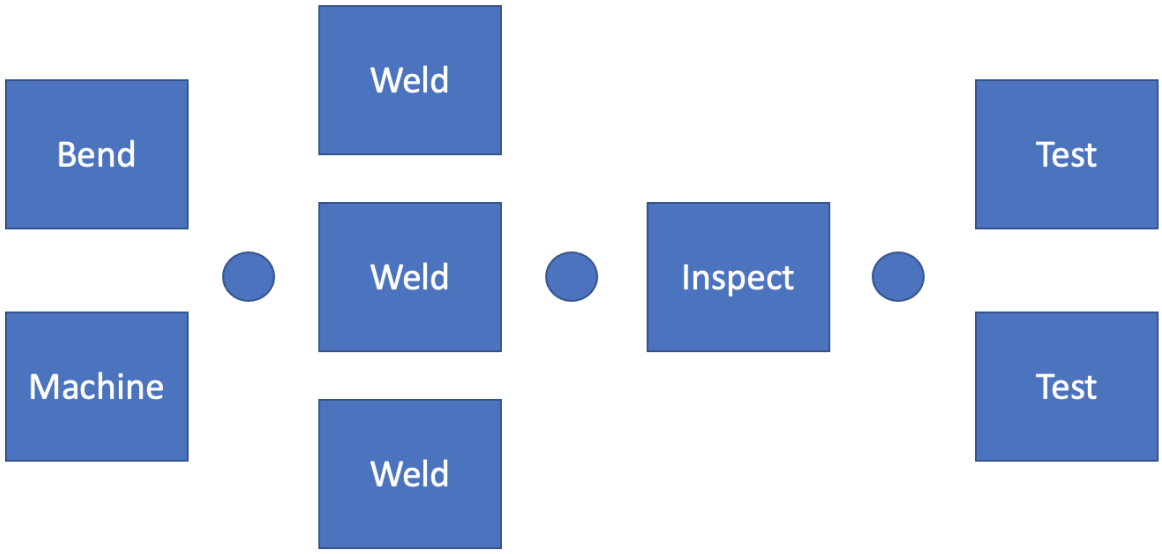
Name:

_____

Part A, In-Class Component		
Problem 1		Out of 10 points
Problem 2		Out of 40 points
Part B, Take-Home Component		
Problem 3		Out of 50 points
Total		**100 points**

<u>Problem 3:</u> Manufacturing Systems

Expanding on the scenario from Part A, to better analyze the assembly line, you have been asked to perform a manufacturing systems analysis on the hub-bracket assembly for the Saildrone mast base. The process has brackets bent on a press and hubs machined on a CNC. Each of these are placed into an intermediary buffer. From there, the three manual welders take one of each to weld together and deposit into another intermediate buffer. The inspector ensures the welded joints meet the required levels of quality through an ultrasonic system. Once inspected, the hub-brackets undergo product testing with two workers in parallel. This constitutes the entire assembly line under investigation. **The operation time and efficiency parameters associated with each process station are listed below in the table.**



Machine	e	MTTR (sec)	MTTF (sec)	Tau (sec)	p	r
Bend	0.8889	2000	16000	60	0.00375	0.030
Machine	0.8000	5000	20000	360	0.01800	0.072
Weld	0.5000	10000	10000	300	0.03000	0.030
Inspect	0.9756	1000	40000	120	0.00300	0.120
Test	0.9697	1000	32000	400	0.01250	0.400

Key Assumptions:

- A human operator acts as a variable machine with irregular downtime.
- There is only buffer space in the designated circles and unless otherwise outlined starts at zero.
- The hub-bracket parts move left to right.

a) What simplifications or assumptions do you need to make in order to utilize the analytical solutions in MATLAB? Draw this new line.

b) If you had the option to place an infinite buffer anywhere, where would it go to have the maximum effect?

c) Each buffer between machines only has space for a maximum of 25 hub-brackets. Can you meet the demand of 100 hub-brackets per day? Explain the distribution of parts in your buffers if so.

d) What is the minimum total buffer size that you need to meet this demand?

To accommodate increasing demand of 150 parts/day now, management purchases a new Path Robotics system (Figure 1) that has speedy automation to replace the 3 manual welders, a vision system to make the inspector unnecessary, and because of the excellent precision quality, does not require any post-process testing either. The reliability and operational metrics are listed below along with the same bending and machining step.

Figure 1: Path Robotics Automated Welder and Inspector

Machine	e	MTTR (sec)	MTTF (sec)	Tau (sec)	p	r
Bend	0.8889	2000	16000	60	0.00375	0.030
Machine	0.8000	5000	20000	360	0.01800	0.072
Path	0.7143	2000	5000	360	0.07200	0.180

e) Can you meet the increased demand? What is the minimum total buffer size that you need now? Explain the approximate relationship of nbar to N for this optimum case.

f) What is the average time that your hub bracket is in the manufacturing line for this Path Robotics line and minimum buffer size?

g) What is the maximum failure rate that Path Robotics can have before it drops below the previous demand of 100 parts/day using the same minimum buffer size?

2.008 Design and Manufacturing II

Spring 2025