PIETS' College of Engineering, Pune [CoEP]

(An Autonomous Institute of Government of Maharashtra)

END SEMESTER EXAMINATION

(PE – 407) MANUFACTURING AUTOMATION

Programme :- B. Tech. (Production Sandwich)
Duration :- 3 Hrs.
Max. Marks :- 50

Date :- / / 2012
Year :- 2012 – 2013
Semester :- I (Autumn)

Instructions:-

1. **Question no. 1, 2 are compulsory and solve any 3 from the remaining.**
2. Figures to the right indicate full marks.
3. Draw neat sketches wherever required.
4. Use of pocket calculators is allowed.
5. Assume suitable data wherever necessary.

Q.1. (A) Three models A, B, and C are to be assembled on a mixed model line. Hourly production rates for the three models are A, 15 units/hr; B, 10 units/hr; and C, 5 units/hr. The work elements, element times, and precedence requirements are given in the table below. Assume line efficiency, E = 0.96, repositioning efficiency, E_r = 0.95, and manning level, M_i = 1. **(5)**

Element	T_{eAk} (min)	Preceded by	T_{eBk} (min)	Preceded by	T_{eCk} (min)	Preceded by
1	0.6	-	0.6	-	0.6	-
2	0.5	1	0.5	1	0.5	1
3	0.9	1	0.9	1	0.9	1
4	-	-	0.5	1	-	-
5	-	-	-	-	0.6	1
6	0.7	2	0.7	2	0.7	2
7	1.3	3	1.3	3	1.3	3
8	-	-	0.9	4	-	-
9	-	-	-	-	1.2	5
10	0.8	6,7	0.8	6,7,8	0.8	6,7,9
T_{wc}	4.8		6.2		6.6	

(i) Construct the precedence diagram for each model and for all three models combined into one diagram,
(ii) Find the theoretical minimum number of workstations required to achieve the required production rate,
(iii) Use the Kilbridge and Wester method to solve the line balancing problem
(iv) Determine the Balance Efficiency, Balance Delay and Smoothness Index for the solution in (iii)
(v) Determine the fixed rate launching interval and
(vi) The launch sequence of models A, B, and C during one hour of production.

(B) An eight-station assembly machine has an ideal cycle time of 6 sec. The fraction defect rate at each of the eight stations is q = 0.015. When a breakdown occurs, it takes one minute, on average, for the system to put back into operation. Determine the production rate for the assembly machine, the yield of good product (final assemblies containing no defective components), and proportion uptime of the system for the following three cases. **(5)**
(i) a defect always jams the affected station
(ii) defect never jams the workstation
(iii) assume that m = 0.6 for all stations.

Q.2. (A) A two week study has been performed on a 12-station transfer line that is used to partially machine engine heads for a major automotive company. During the 80 hours of observation, the line was down a total of 42 hours, and a total of 1689 parts were completed under the consideration that machine breakdown has not affected the workpiece. The accompanying table lists the machining operation performed at each station, the process times and the downtime occurrences for each station. **(5)**

Station	Operation	Process Time (min)	Downtime Occurrences
1	Load Part (Manual)	0.50	00
2	Rough mill top	1.10	15
3	Finish mill top	1.25	18
4	Rough mill sides	0.75	23
5	Finish mill sides	1.05	31
6	Mill surfaces for drill	0.80	09
7	Drill two holes	0.75	22
8	Tap two holes	0.40	47
9	Drill three holes	1.10	30
10	Ream three holes	0.70	21
11	Tap three holes	0.45	30
12	Unload & inspect part (Manual)	0.90	00
	Total	9.40	246

Transfer time between stations is 6 sec. To address the downtime problem, it has been proposed to divide the line into two stages, each consisting of six stations. The storage buffer between the stages would have a storage capacity of 20 parts. Determine:

(i) Line efficiency and production rate of the current one-stage configuration, and
(ii) Line efficiency and production rate of the proposed two-stage configuration (assuming constant downtime distribution).

(B) Explain the basic blocks of Embedded system with one example. **(3)**

(C) A controlling variable is a motor speed that varies from 800 to 1750 rpm. If the speed is controlled by a 25- to 50-V DC signal, calculate: **(2)**

(i) The speed produced by an input of 38 V, and
(ii) The speed calculated as a percent of span.

Q.3. (A) A worker is currently responsible for tending two machines in a machine cluster. The service time per machine is 0.35 min. And the time to walk between machines is 0.15 min. The machine automatic operation time is 1.90 min. If the worker's hourly rate = Rs. 100/hr and the hourly rate for each machine = Rs. 150/hr, determine: **(5)**

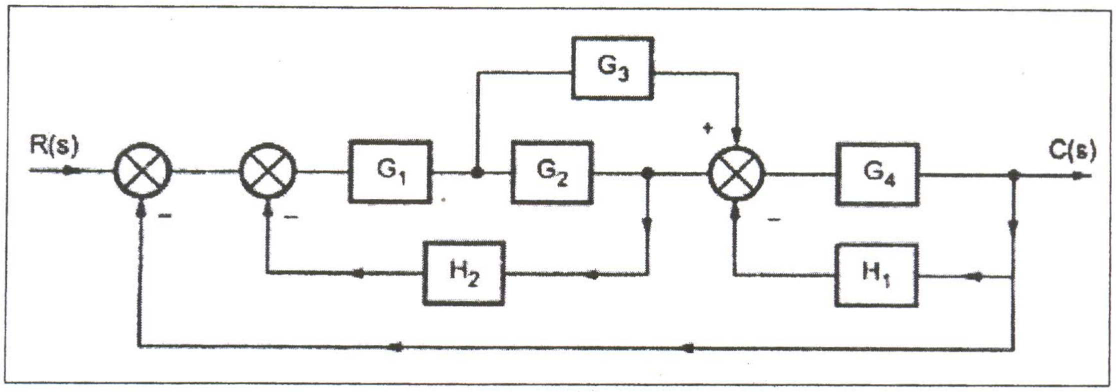
(i) The current hourly rate for the cluster,
(ii) The current cost per unit of product, given that two units are produced by each machine during each machine cycle,
(iii) The idle time of the worker,
(iv) The optimum number of machines that should be used in the machine cluster, if minimum cost per unit of product is the decision criterion?

(B) (i) What is neutral zone in Two-position Controller? **(3)**
(ii) What is a bottleneck station?
(iii) What is the difference between an active sensor and a passive sensor?

(C) A Geneva mechanism with eight slots is used to operate the worktable of a dial indexing machine. The slowest workstation on the dial indexing machine has an operation time of 2.5 sec, so the table must be in a dwell position for this length of time. **(2)**

(i) At what rotational speed must the driving and driven member of the Geneva mechanism be turned to provide this dwell time?
(ii) What is the indexing time each cycle?
(iii) What is the cycle time?

Q.4. **(A)** Reduce the block diagram to its canonical form and obtain the transfer function T(s) = C(s)/R(s). **(5)**



(B) Specify the following on chip peripherals of 8051 microcontroller. **(3)**

On-chip-Peripheral	Quantify For 8051
RAM	
ROM	
Timers/Counters	
Serial Port	
I/O Ports	
Interrupt sources	

(C) (i) What is Controller? Explain its function in a system. **(2)**
(ii) What are some of the reasons why companies automate their operations? Name any four.

Q.5. **(A)** Write short note on: **(5)**
(i) PID Controller.
(ii) Analog-to-Digital Conversion.

(B) Discuss the criteria for choosing a microcontroller. **(3)**

(C) (i) Name any two, each for, factory overhead expenses and corporate overhead expenses. **(2)**
(ii) Name any four PLC programming methods.

Q.6. **(A)** An elevator's automatic door opening system consisting of a pneumatic double acting cylinder must be controlled with a timed cycle through PLC. The door operation can be controlled from both inside and outside of the elevator by a manual push button. **(5)**

Parameters:
(i) When any of the push buttons is pressed door should open quickly, remain in open position for 5 seconds and then close slowly.
(ii) While door closing, if any of the push button is pressed door should open quickly, remain in open position for 5 seconds again and then close slowly.
(iii) While door is in open position pressing of any of the push button should extend the door opening time by same delay period and then close slowly.

Design a pneumatic circuit and the corresponding ladder logic diagram for the above requirement. List the inputs to and outputs from the PLC.

(B) Answer any five questions: **(5)**

(i) What is the difference between a closed loop control system and an open loop control system?

(ii) What is an interlock? What are the two types of interlocks in Industrial Control?

(iii) Differentiate between single direction, continuous and recirculating conveyor.

(iv) What is a Class based Dedicated Storage strategy?

(v) What are the relative advantages of RFID over bar codes?

(vi) What are the three classifications of production machines, in terms of worker participation?

(vii) What is the difference between parts feeder and feed track?

Formulas for Computing $h(b)$ for a Two-Stage Automated Production Line Under Several Downtime Distributions

Assumptions and definitions: Assume that the two stages have equal downtime distributions ($T_{d1} = T_{d2} = T_d$) and equal cycle times ($T_{c1} = T_{c2} = T_c$). Let F_1 = downtime frequency for stage 1, and F_2 = downtime frequency for stage 2. Define r to be the ratio of breakdown frequencies as follows:

$$r = \frac{F_1}{F_2}$$

Equations for $h(b)$: With these definitions and assumptions, we can express the relationships for $h(b)$ for two theoretical downtime distributions as derived by Buzacott [2]:

Constant downtime: Each downtime occurrence is assumed to be of constant duration T_d. This is a case of no downtime variation. Given buffer capacity b, define B and L as follows:

$$b = B\frac{T_d}{T_c} + L$$

where B is the largest integer satisfying the relation: $b\frac{T_c}{T_d} \geq B$,

and L represents the leftover units, the amount by which b exceeds $B\frac{T_d}{T_c}$. There are two cases:

$$\text{Case 1: } r = 1.0.\ h(b) = \frac{B}{B+1} + L\frac{T_c}{T_d}\frac{1}{(B+1)(B+2)}$$

$$\text{Case 2: } r \neq 1.0.\ h(b) = r\frac{1 - r^B}{1 - r^{B+1}} + L\frac{T_c}{T_d}\frac{r^{B+1}(1-r)^2}{(1 - r^{B+1})(1 - r^{B+2})}$$

Geometric downtime distribution: In this downtime distribution, the probability that repairs are completed during any cycle duration T_c is independent of the time since repairs began. This is a case of maximum downtime variation. There are two cases:

$$\text{Case 1: } r = 1.0.\ h(b) = \frac{b\frac{T_c}{T_d}}{2 + (b-1)\frac{T_c}{T_d}}$$

$$\text{Case 2: } r \neq 1.0.\ \text{Define } K = \frac{1 + r - \frac{T_c}{T_d}}{1 + r - r\frac{T_c}{T_d}} \qquad \text{then } h(b) = \frac{r(1 - K^b)}{1 - rK^b}$$
