# 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) | Date :- | / / 2013 |
| Duration :- | 3 Hrs. | Year :- | 2013 – 2014 |
| Max. Marks :- | 60 | Semester :- | I (Autumn) |

**Instructions:-**

1. **Attempt only five questions.**
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)** Answer the following questions: **(7)**

(i) What are the four functions included within the scope of manufacturing support systems?
(ii) What are the different industry categories? Give one example of each.
(iii) What is a part complexity and product complexity?
(iv) In manual assembly line what is a bottleneck station? And what do the terms starving and blocking means?
(v) What is a storage buffer as the term is used for an automated production line? Name three reasons for including a storage buffer in an automated production line.
(vi) Enlist any four automated assembly system configurations.
(vii) Considering the automated assembly machine as a game of chance, what are the three possible events that might occur when the feed mechanism attempts to feed the next component to the assembly workhead at a given workstation in a multi-station system?

**(B)** The XYZ company is planning to introduce a new product line and will build a new factory to produce the parts and assembly the final products for the product line. The new product line will include 100 different models. Annual production of each model is expected to be 1000 units. Each product will be assembled of 600 components. All processing of parts and assembly of products will be accomplished in one factory. There are an average of 10 processing steps required to produce each component, and each processing step takes 30 sec. (includes an allowance for set up time and part handling). Each final unit of product takes 3 hours to assemble. All processing operations are performed at work cells that include a production machine and a human worker. Products are assembled on single workstations consisting of two workers each. If each work cell and each workstation require 200 $ft^2$, and the factory operates three shifts (6000 hr/yr), determine: **(3)**

(i) how many production operations,
(ii) how much floor space and
(iii) how many workers will be required in the plant.

**(C)** What is direct and reverse action in controllers? **(2)**

**Q.2. (A)** An AGVS has an average loaded travel distance per delivery = 400 ft. The average empty travel distance is not known. Required number of deliveries per hour = 60. Load and unload times are each 0.6 min and the AGV speed = 125 ft/min. Anticipated traffic factor = 0.85 and availability = 0.95. Develop an equation that relates the number of vehicles required to operate the system as a function of the average empty travel distance $D_e$. **(6)**

**Q.2.** **(B)** The hourly production rate and work content time for three models A, B and C to be produced on a mixed model assembly line are A, 4 units/hr and 27 min; B,6 units/hr and 25 min; C, 2 units/hr and 30 min respectively. Line efficiency E = 0.96, repositioning time $T_r$ = 0.15 min and manning level, $M_i$ = 1. Determine: **(6)**

(i) the theoretical minimum number of workers required on the assembly line,
(ii) the actual number of workers by adjusting the available time for line efficiency E and repositioning efficiency $E_r$,
(iii) approximate balance efficiency,
(iv) variable rate launching interval time for models A, B and C
(v) fixed rate launching interval time and
(vi) the launch sequence of models A, B and C during the hour.

**Q.3.** **(A)** A 20 station transfer line is divided into two stages of 10 stations each. The ideal cycle time of each stage is $T_c$ = 1.2 min. All of the stations in the line have the same probability of stopping, p = 0.005. Assume that the downtime is constant when a breakdown occurs, $T_d$ = 8.0 min. Compute the line efficiency and production rates for the following buffer capacities: **(6)**

(i) b = 0,
(ii) b = ∞,
(iii) b = 10 and
(iv) b = 100.

**(B)** Explain the function of following port pins in context with 8051 microcontroller: **(6)**

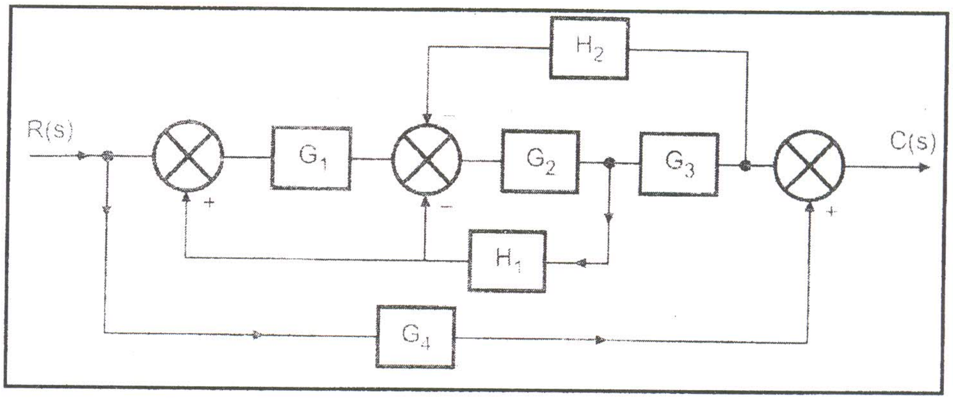
(i) EA/VPP
(ii) PSEN
(iii) ALE/PROG
(iv) INT0
(v) T0
(vi) RxD

**Q.4.** **(A)** A tank is to be filled by using two input valves A and B in the following sequence: **(6)**

Fill the tank to level A from valve A.
Fill the tank to level B from valve B.
Start a timer, heat and stirr for 5 min.
Open output valve C until the tank gets drained off. (Sense the empty tank)

A manual push button is used to start each cycle.
Draw ladder logic diagram for the above requirement. List the inputs to and outputs from the PLC.
Hint: Use sensors to sense level A, level B, and empty tank. Use timer to operate heater, and motor for stirrer.

**(B)** Reduce the block diagram to its canonical form and obtain the transfer function: **(6)**



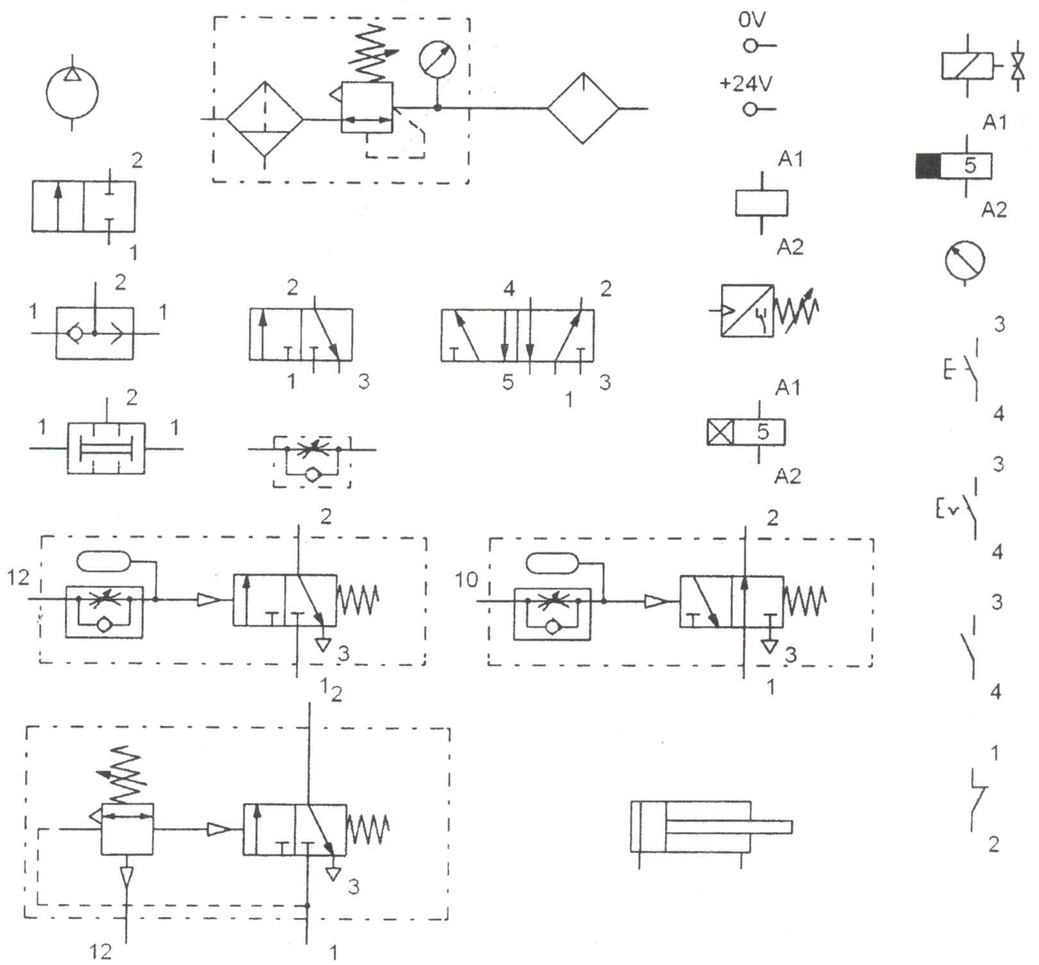
**Q.5.** **(A)** Discuss the architecture of 8051 microcontroller in context with **(6)**
(a) On-chip memory
(b) Communication ports
(c) Timers/Counters

**(B)** Design a Pneumatic or Electro-pneumatic Circuit for the following requirement. **(6)**

An electrically heated rail is pressed onto a rotatable cold drum by a double acting cylinder, and welds a continuous plastic sheet into a tube. The forward stroke is triggered by means of a push button.
The maximum cylinder force is set to 5 bar via a pressure regulator with pressure gauge, so that the welding rail cannot damage the metal drum. The return stroke is not initiated until the forward end position is acknowledged and the pressure in the piston area has reached 4 bar.
The supply air for the forward stroke is throttled, so that the pressure develops slowly after the cylinder reaches the forward end position. The cylinder is to be held in this position not exceeding 4 bar pressure for 5 seconds before it retracts.
The return stroke must occur even if the start push button is kept pressed continuously.
A new start signal must only become effective, after the initial position has been reached and the push button has been released.

**OR**

**Q.6.** Write short notes on: **(12)**
(a) Analog to Digital Conversion (ADC)
(b) Control Actions
(c) 'Parts Delivery at Workstations' in an Automated Assembly System



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:

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

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