COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra.)
SHIVAJI NAGAR, PUNE - 411 005

END Semester Examination

(PE-14003) Mechatronics & Automation

Course: B.Tech Branch: Production Engineering (Sandwich)

Semester: Sem VII

Year: 2014-2015 Max.Marks:60

Duration: 3 Hours Time:- 2 pm to 5 pm **Date:26/11/2014**

Instructions: **MIS No.** | | | | | | | | | |

1. Figures to the right indicate the full marks.
2. Mobile phones and programmable calculators are strictly prohibited.
3. Writing anything on question paper is not allowed.
4. Exchange/Sharing of anything like stationery, calculator is not allowed.
5. Assume suitable data if necessary.
6. Write your MIS Number on Question Paper

Q.1. (A) A manual assembly line operates with a mechanized conveyor. The conveyor moves at a speed of 5 ft/min, and the spacing between base parts launched onto the line is 4 ft. It has been determined that the line operates best when there is one worker per station and each station is 6 ft long. With 100 % repositioning efficiency the cycle time to operate the assembly line is 0.8 min. There are 14 work elements that must be accomplished to complete the assembly, and the element times and precedence requirements are listed in the table below. **(6)**

Element	T_{ek} (min)	Preceded by		Element	T_{ek} (min)	Preceded by
1	0.2	-		8	0.2	5
2	0.5	-		9	0.4	5
3	0.2	1		10	0.3	6,7
4	0.6	1		11	0.1	9
5	0.1	2		12	0.2	8,10
6	0.2	3,4		13	0.1	11
7	0.3	4		14	0.3	12,13

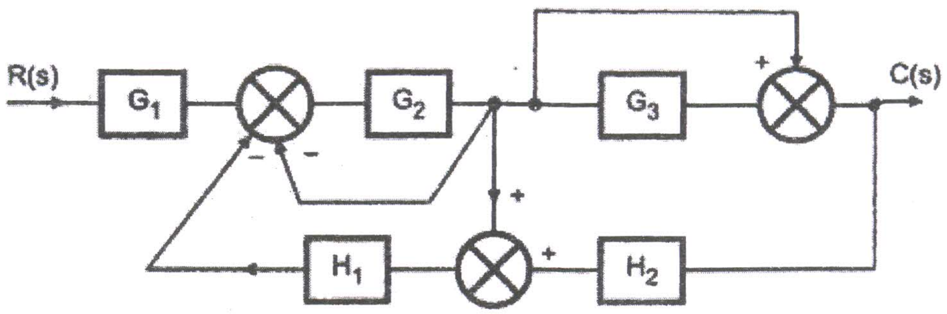
Construct the precedence diagram for this and determine:
(i) total work content time (T_{wc}),
(ii) theoretical minimum number of workers required on the line,
(iii) service time to which the line must be balanced,
(iv) line balance efficiency, use one of the line balancing algorithms to balance the line,
(v) balance delay for the solution (iv) and
(vi) smoothness index for the solution (iv)

(B) A 20-station transfer line presently operates with a line efficiency E = 0.30. The ideal cycle time = 1.0 min. The repair distribution is geometric with an average downtime per occurrence = 8 min, and each station has an equal probability of failure. It is possible to divide the line into two stages with 10 stations each, separating the stages by a storage buffer of capacity b. With the information given, determine the required value of b that will increase the efficiency from E = 0.30 to E = 0.40. ***(Refer data on page 4)*** **(6)**

Q.2. (A) Answer the following questions: **(6)**

(i) Compare automated production lines (transfer lines) with automated assembly systems.
(ii) Name four typical products that are made by automated assembly.
(iii) Name any four typical assembly processes/activities used in automated assembly systems.
(iv) In an automated assembly system, what are the typical hardware components of a workstation parts delivery system?
(v) 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?
(vi) What are two reasons for the existence of partially automated production/assembly lines?

(B) Reduce the block diagram to its canonical form and obtain the transfer function $T(s) = C(s)/R(s)$ **(6)**



OR

(C) Write a short note on PID Controller. **(6)**

Q.3. (A) State the classification of hydraulic motors. Explain the working of vane motor. How is such a motor specified? **(6)**

(B) Consider a double acting cylinder subjected to a load. The cylinder is connected to a spool valve the shaft of which is connected to torque motor. Derive an expression for the relationship between the input and output as: **(6)**

$$\frac{x_2}{x_1} = \frac{A\dfrac{k_1}{k_2}}{Ms^2 + \left(f + \dfrac{A^2}{k_2}\right)s}$$

Q.4. (A) A material handling system consisting of two pneumatic double acting cylinders operates in following sequence: **(6)**

(i) First cylinder extends
(ii) Second cylinder extends
(iii) Second cylinder remains in extended position for 5 seconds
(iv) Second cylinder retracts
(v) First Cylinder retracts
(vi) The signal for the commencement of next cycle will be effective only after 5 seconds i.e. a delay of 5 seconds is required in between two cycles.

Signal to start the sequencing operation is given through momentary pressing of a manual push button.

This pneumatic sequencing operation is controlled through a Programmable Logic Controller (PLC).

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

Also draw a time-step travel or position-step diagram for the pneumatic sequencing circuit.

Q.4. (B) Answer the following questions: **(6)**

(i) Name the three phases of a typical automation migration strategy.

(ii) Name the different types of production plants on the basis of n_p and n_o. Where n_p = the number of parts per product and n_o = the number of operations or processing steps to make a part.

(iii) In advanced automation function of safety monitoring name any four possible responses to various hazards.

(iv) Draw a neat sketch of typical direct digital control system showing its different components.

(v) What is the difference between an event-driven change and a time-driven change in discrete control?

(vi) The step angle of a certain stepper motor = 1.8°. The application of interest is to rotate the motor shaft through 10 complete revolutions at an angular velocity of 20 rad/sec. Determine the required number of pulses.

OR

(C) The average parts produced in a certain batch manufacturing plant must be processed through an average of six machines. There are 20 new batches of parts launched each week. Other pertinent data are as follows: **(6)**

average operation time per part = 6 min/machine
average setup time per batch = 5 h/machine
average batch size = 25 parts
average non-operation time per batch = 10 h/machine

There are 18 machines in the plant. The plant operates an average of 70 production hours per week. Scrap rate is negligible.

(i) Determine the manufacturing lead time for the batch
(ii) Determine the plant capacity
(iii) Determine the plant utilization

Q.5. (A) Explain the significance of the following in a microcontroller: **(6)**

(i) Program Counter
(ii) Crystal Oscillator
(iii) PSW
(iv) Stack Pointer
(v) Subroutines
(vi) Cross Complier

(B) What are the different addressing modes in 8051? Elaborate and justify. Also explain the following instructions with proper example: **(6)**

(i) LJMP
(ii) PUSH and POP
(iii) ADDC A, source byte

Supplementary information for Q. 2. (B)

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:

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

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