UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR OF TECHNOLOGY ENGINEERING : INDUSTRIAL
SUBJECT	:	**PRODUCTION TECHNOLOGY IV**
CODE	:	**IPT411**
DATE	:	WINTER SSA EXAMINATION 19 JULY 2019
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	50 : 50
TOTAL MARKS	:	100

ASSESSORS	:	MR F CHIROMO
MODERATOR	:	MR K SITHOLE
NUMBER OF PAGES	:	4 PAGES

INSTRUCTIONS :

- A CALCULATOR OF ANY MAKE OR MODEL IS PERMITTED.
- ANSWER ALL QUESTIONS.
- NUMBER YOUR QUESTIONS CLEARLY.

QUESTION 1

1.1 Discuss three problem areas that must be considered in the analysis and design of an automated production line. (6)

1.2 A 30 station transfer line has an ideal cycle time of 0.75 min, an average downtime of 6.0 min per line stop occurrence, and a station failure frequency of 0.01 for all stations. A proposal has been submitted to locate a storage buffer between stations 15 and 16 to improve line efficiency. Determine:

1.2.1 the current line efficiency and production rate; (2)

1.2.2 the current line production rate; (1)

1.2.3 the maximum possible line efficiency that would result from installing the storage buffer; (2)

1.2.4 the maximum possible line production rate that would result from installing the storage buffer. (1)

[12]

QUESTION 2

2.1 Discuss two reasons for the existence of partially automated production lines in a production environment. (4)

2.2 An eight-station automatic assembly machine has an ideal cycle time of 10 seconds. Downtime is caused by defective parts jamming at the individual assembly stations. The average downtime per occurrence is 3.0 minutes. The fraction defect rate is 1.0% and the probability that a defective part will jam at a given station is 0.6 for all stations. The cost to operate the assembly machine is R90 per hour and the cost of components being assembled is R0.60 per unit assembly. Ignore other costs. Determine:

2.2.1 yield of good assemblies; (2)

2.2.2 average production rate of good assemblies; (4)

2.2.3 proportion of assemblies with at least one defective component, and; (2)

2.2.4 unit cost of the assembled product. (2)

[14]

QUESTION 3

3.1 Two inspection alternatives are to be compared for a processing sequence consisting 20 operations that are performed on a batch of 100 starting parts: (1) one final inspection and sortation operation following the last processing operation, and (2) distributed inspection with an inspection and sortation operation after each processing operation. The cost of each processing operation, C_{pr}, is R1.00 per unit processed. The fraction defect rate at each operation, q, is 0.03. The cost of the single final inspection and sortation operation in alternative (1) is C_{sf} is R2.00 per unit. The cost of each inspection and sortation operation in alternative (2) is C_s is R0.10 per unit.

Compare total processing and inspection costs per batch for the two cases. (6)

(Question 3 – continued)

3.2 In 3.1, instead of inspecting and sorting after every operation, the 20 operations will be divided into groups of five, with inspections after operations 5, 10, 15, and 20. Following the logic of the equation, $Csf = \sum_{i=1}^{n} C_{si}$, the cost of each inspection will be five times the cost of inspecting for one defect feature; that is, $C_{s5} = C_{s10} = C_{s15} = C_{s20}$ = 5(R0.10) = R0.50 per unit inspected. Processing cost per unit for each operation remains the same as before at C_{pr} = R1.00, and Q_o = 100 parts.
Determine the total processing and inspection cost per batch for this partially distributed inspection system. (4)

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QUESTION 4

4.1. Discuss the four categories into which the methods of operating and controlling a coordinate measuring machines (CMM) can be classified. (4)

4.2 The coordinates of the intersection of two lines are to be determined using a CMM to define the equations for the two lines. The two lines are the edges of a machined part, and the intersection represents the corner where the two edges meet. Both lines lie in the x-y plane. Measurements are in inches. Two points are measured on the first line to have coordinates of (5.254, 10.430) and (10.223, 6.052). Two points are measured on the second line to have coordinates of (6.101, 0.657) and (8.970, 3.824). The coordinate values have been corrected for probe radius. Determine:

4.2.1 the two equations for the two lines in the form of $x + Ay + B = 0$; (12)

4.2.2 the coordinates of the intersection of the two lines. (4)

4.23 The edges represented by the two lines are specified to be perpendicular to each other. Calculate the angle between the two lines to determine if the edges are perpendicular. (4)

[24]

QUESTION 5

5.1 Discuss the factors that influence the make or buy decisions in a manufacturing entity. (16)

5.2 Discuss the significance of manufacturing support systems in a production environment. (4)

[20]

QUESTION 6

6.1 Briefly discuss the following three phases of shop floor control:
6.1.1 Order release; (2)
6.1.2 Order scheduling; (2)
6.1.3 Order progressing. (2)
6.2 An injection moulding machine used to produce 25 different plastic moulded parts in a typical year. Annual demand for a typical part is 20 000 units. Each part is made out of a different plastic (the differences are in type of plastic and colour). Because of the differences, changeover time between parts is significant, averaging 5 hours to (1) change moulds and (2) purge the previous plastic from the injection barrel. One setup person normally does these two activities sequentially. A proposal has been made to separate the tasks and use two setup persons working simultaneously. In that case, the mould can be changed in 1.5 hours and purging takes 3.5 hours. Thus, the total downtime per changeover will be reduced to 3.5 hours from the previous 5 hours. Downtime on the injection-moulding machine is R200/hr. labour cost for set time is R20/hr. average cost of a plastic moulded part is R2.50, and holding cost is 24% annually. For the 5 hour setup, determine:
6.2.1 the economic batch quantity; (2)
6.2.2 the total number of hours per year that the injection-moulding machine is down for changeovers; and (3)
6.2.3 the annual inventory cost. (2)
6.2.4 For the 3.5-hour setup, determine:
6.2.4.1 the economic batch quantity; (2)
6.2.4.2 the total number of hours per year that the injection-moulding machine is down for changeover; (3)
6.2.4.3 the annual inventory cost. (2)

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TOTAL = 100

ANNEXURE

FORMULA SHEET

$$T_p = T_c + FT_d; \qquad F = \sum_{i=1}^{n} p_i; \qquad F = np$$

$$R_p = \frac{1}{T_p}; \qquad R_c = \frac{1}{T_c}; \qquad E = \frac{T_c}{T_p} = \frac{T_c}{T_c + FT_d}; \qquad T_r = \frac{(180-\theta)}{360N}$$

$$C_{pc} = C_m + C_o T_p + C_t; \qquad \theta = \frac{360}{n_s}; \qquad T_c = \frac{1}{N}; \qquad T_s = \frac{(180+\theta)}{360N}$$

$$T_c = Max\{T_{si}\} + T_r; \qquad D = \frac{FT_d}{T_p} = \frac{FT_d}{T_c + FT_d}; \qquad E + D = 1.0$$

$$E_k = \frac{T_c}{T_c + F_k T_{dk}}; \qquad E_b = E_o + D_1^{'} h(b) E_2; \qquad E_o = \frac{T_c}{T_c + (F_1 + F_2)T_d}$$

$$D_1^{'} = \frac{F_1 T_d}{T_c + (F_1 + F_2)T_d}; \qquad r = \frac{F_1}{F_2}; \qquad b = B\frac{T_d}{T_c} + L$$

$$E_\infty = Minimum\{E_k\} for \ k = 1, 2, ..., K; \qquad E_0 \langle E_b \langle E_\infty$$

Constant Downtime:

$$When \ r = 1.0, \ then \ h(b) = \frac{B}{B+1} + L\frac{T_c}{T_d}\frac{1}{(B+1)(B+2)}$$

$$When \ r \neq 1.0, \ then \ h(b) = r\frac{1-r^B}{1-r^{B+1}} + L\frac{T_c}{T_d}\frac{r^{B+1}(1-r)^2}{(1-r^{B+1})(1-r^{B+2})}$$

Geometric Downtime:

$$When \ r = 1.0, \ then \ h(b) \quad \frac{b\frac{T_c}{T_d}}{2 + (b-1)\frac{T_c}{T_d}};$$

$$When\ r \neq 1.0\ \ Define\ K = \frac{1 + r - \frac{T_c}{T_d}}{1 + r - r\frac{T_c}{T_d}} \quad then\ \ h(b) = \frac{r\left(1 - K^b\right)}{1 - rK^b}$$

$$T_c = T_h + \sum_{j=1}^{n_e} T_{ej}; \qquad T_p = T_c + \sum_{j=1}^{n_e} q_j m_j T_d; \qquad T_p = T_c + nmqT_d$$

$$m_i q_i + (1 - m_i)q_i + (1 - q_i) = 1; \qquad mq + (1 - m)q + (1 - q) = 1$$

$$\prod_{i=1}^{n}[m_i q_i + (1 - m_i)q_i + (1 - q_i)] = 1; \qquad [mq + (1 - m)q + (1 - q)]^n = 1$$

$$T_p = T_c + \sum_{i \in n_a} p_i T_d; \qquad p_i = m_i q_i; \qquad T_p = T_c + n_a pT_d$$

$$C_o = C_{at} + \sum_{i \in n_a} C_{asi} + \sum_{i \in n_w} C_{wi}; \quad C_o = C_{at} + n_a C_{as} + n_w C_w$$

$$C_{pc} = \frac{C_m + C_o T_p + C_t}{P_{ap}}; \qquad P_{ap} = \prod_{i=1}^{n}(1 - q_i + m_i q_i);$$

$$R_{ap} = P_{ap} R_p = \frac{P_{ap}}{T_p} = \frac{\prod_{i=1}^{n}\left(1 - q_i + m_i q_i\right)}{T_p};$$

$$R_{ap} = P_{ap} R_p = \frac{P_{ap}}{T_p} = \frac{(1 - q + mq)^n}{T_p}; \qquad C_{pc} = \frac{C_m + C_o T_p + C_t}{P_{ap}}$$

$$T_c = T_h + \sum_{j=1}^{n_e} T_{ej}; \qquad T_p + T_c + \sum_{j=1}^{n_e} q_i m_j T_d; \qquad T_p = T_c + nmqT_d;$$

$$T_p = T_c + \sum_{i \in n_a} p_i T_d; \qquad T_p = T_c + n_a p T_d; \qquad C_o = C_{at} + \sum_{i \in n_a} C_{asi} + \sum_{i \in n_w} C_{wi};$$

$$C_o = C_{at} + n_a C_{as} + n_w C_w; \qquad C_{pc} = \frac{C_m + C_o T_p + C_t}{P_{ap}};$$

$$Q = Q_o(1-q); \qquad D = Q_o q; \qquad Q_f = Q_o \prod_{i=1}^{n}(1-q)$$

$$Q_f = Q_o (1-q)^n; \qquad D_f \; Q_o \; Q_f; \qquad \prod_{i=1}^{n}(p_i + q_i) = 1;$$

$$C_b = Q_o \sum_{i=1}^{n} C_{pri} + Q_o C_{sf} = Q_o\left(\sum_{i=1}^{n} C_{pri} + C_{sf}\right); \qquad C_b = Q_o(nC_{pr} + C_{sf})$$

$$C_b = Q_o(C_{pr1} + C_{s1}) + Q_o(1-q_1)(C_{pr2} + C_{s2}) + Q_o(1-q_1)(1-q_2)(C_{pr3} + C_{s3}) + \dots\dots\dots + Q_o \prod_{i=1}^{n-1}(1-q)(C_{prn} + C_{sn})$$

$$C_b = Q_o\left(1 + (1-q) + (1-q)^2 + \dots\dots\dots\dots\dots + (1-q)^{n-1}\right)(C_{pr} + C_s)$$

$$C_{sf} = \sum_{i=1}^{n} C_{si}; \qquad C_{sf} = nC_s$$

$$C_b\,(100\%\,inspection) = QC_s; \qquad C_b(no\ inspection) = QqC_d$$

$$C_b(sampling) = C_s Q_s + (Q - Q_s)qC_d P_a + (Q - Q_s)C_s(1-P_a)$$

$$q_c = \frac{C_s}{C_d}$$

$$C_b = Q_o\left(\sum_{i=1}^{n} C_{pri} + C_{sn}\right) + Q_o \prod_{i=1}^{n}(1-q_i)\left(\sum_{i=1+n}^{2n} C_{pri}\, C_{s(2n)}\right) + \dots\dots\dots\dots\dots$$

$$C_b = Q_o(nC_{pr} + C_{s(n)}) + Q_o(1-q)^n(5C_{pr} + C_{s(2n)}) + \dots\dots\dots\dots\dots$$

$n_o = 2^B;$ $\quad MR = \dfrac{L}{n_o - 1} = \dfrac{L}{2^B - 1}$

$L = \pm\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2};$ $\quad L = \pm\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$

$(x - a)^2 + (y - b)^2 = R^2;$ $\quad (x - a)^2 + (y - b)^2 + (z - c)^2 = R^2$

$x + Ay + B = 0;$ $\quad y = mx + b$

$x + Ay + Bz + C = 0$

$R_a = \int_0^L \dfrac{|y|}{L} dx;$ $\quad R_a = \dfrac{\sum_{i=1}^{n} |y_i|}{n};$

$R = L\cot A$

$TIC = \dfrac{C_h Q}{2} + \dfrac{C_{su} D_a}{Q};$ $\quad C_h = hC_{pc};$ $\quad C_{su} = T_{su} C_{dt}$

$TC = D_a C_{pc} + \dfrac{C_h Q}{2} + \dfrac{C_{su} D_a}{Q};$ $\quad Q = EOQ = \sqrt{\dfrac{2D_a C_{su}}{C_h}}$

$C_{pc} = C_m + n_o(C_o T_p + C_{no});$ $\quad C_p = n_o(C_o T_p + C_{no})$

$TC_{pc} = C_m + C_p + \int_0^{MLT} \left(C_m + \dfrac{C_p t}{MLT}\right) h dt;$ $\quad TC_{pc} = C_m + C_p + \left(C_m + \dfrac{C_p}{2}\right) h(MLT)$

$Holding\ \cos t / pc = \left(C_m + \dfrac{C_p}{2}\right) h(MLT)$

$Y = 1 - q;$ $\quad OEE = AUYr_{os};$ $\quad T_{takt} = \dfrac{EOT}{Q_{dd}}$