UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR OF TECHNOLOGY ENGINEERING : INDUSTRIAL
SUBJECT	:	**PRODUCTION TECHNOLOGY IV**
CODE	:	**IPT411**
DATE	:	WINTER EXAMINATION 4 JUNE 2019
DURATION	:	(SESSION 2) 12:30 - 15:30
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 industrial applications of automated production lines. (6)

1.2 A 20 station transfer line presently operates with a line efficiency E =1/3. The ideal cycle time is 1.0 min. The repair distribution is geometric with an average downtime per occurrence of 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 = 1/3 to E =2/5. (12)

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QUESTION 2

2.1 Discuss the effects of poor quality parts on the performance of an automated assembly system. (4)

2.2 A single station robotic assembly system performs a series of five assembly elements, each of which adds a different component to a base part. Each element takes 4.5 seconds. In addition, the handling time needed to move the base part into and out of position is 4 seconds. For identification, the components, as well as the elements that assemble them, are numbered 1, 2, 3, 4 and 5. The fraction defect is 0.005 for all components, and the probability of a jam by a defective component is 0.7. Average downtime per occurrence is 2.5 minutes. Determine:

2.2.1 production rate; (4)

2.2.2 yield of good product in the output; (2)

2.2.3 uptime efficiency; (2)

2.2.4 proportion of the output that contains a defective type 3 component. (4)

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QUESTION 3

An inspector's accuracy has been assessed as follows: p_1 is 0.94 and p_2 is 0.80. The inspector is given the task of inspecting a batch of 200 parts and sorting out the defects from good units. If the actual defect rate in the batch "q" is 0.04, determine:

3.1 the expected number of Type I errors the inspector will make, and (4)

3.2 the expected number of Type II errors the inspector will make; (4)

3.3 the expected fraction defect rate that the inspector will report at the end of the inspection task. (4)

Note: p_1= proportion of times (probability) that a conforming item is classified as conforming

p_2 = proportion of times (probability) that a nonconforming item is classified as nonconforming.

q = actual fraction defect rate in the batch of items.

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QUESTION 4

Three point locations on the flat surface of a part have been measured by a coordinate measuring machine (CMM). The three point locations are (225.21, 150.23, 40.17), (14.24, 140.92, 38.29), and (12.56, 22.75, 38.02), where the units are in millimetres. The coordinates have been corrected for probe radius.

4.1.1 Determine the equation for the plane in the form of $x + Ay + Bz + C = 0$. (14)

4.1.2 To assess flatness of the surface, a fourth point is measured by the CMM. If its coordinates are (120.22, 75.34, 39.26), determine the vertical deviation of this point from the perfectly flat plane determined in 4.1.1. (6)

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QUESTION 5

5.1 Compare and contrast rapid prototyping and virtual prototyping. (6)

5.2 Discuss the benefits associated with computer –aided process planning. (8)

[14]

QUESTION 6

6.1 Discuss your understanding of the 5S system. (7)

6.2 A two bin approach is used to control inventory for a certain low cost hardware item. Each bin holds 500 units of the item. When one bin becomes empty, an order for 500 units is released to replace the stock in that bin. The order lead time is slightly less than the time it takes to deplete the stock in one bin. Accordingly, the chance of a stock-out is low and the average inventory level of the item is about 250 units, perhaps slightly more. Annual usage of the item is 6 000 units. Ordering cost is R40.

6.2.1 Determine the holding cost per unit for this item. (4)

6.2.2 If the actual annual holding cost per unit is 5 cents, determine the lot size that should be ordered. (3)

6.2.3 Determine what the current two-bin approach cost the company per year compared to using the economic order quantity. (6)

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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:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$x + Ay + Bz + C = 0$

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

$R = L \cot A$

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

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

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

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

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

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