UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR OF TECHNOLOGY *ENGINEERING : INDUSTRIAL*
SUBJECT	:	**PRODUCTION TECHNOLOGY**
CODE	:	**IPT411**
DATE	:	WINTER SSA EXAMINATION 29 JULY 2016
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

ASSESSOR	:	F CHIROMO
MODERATOR	:	K SITHOLE
NUMBER OF PAGES	:	4 PAGES + ANNEXURE

INSTRUCTIONS TO STUDENTS:

- ANSWER ALL QUESTIONS.
- A STUDENT IS EXPECTED TO MAKE REASONABLE ASSUMPTIONS FOR DATA NOT SUPPLIED.
- NUMBER YOUR QUESTIONS CLEARLY AND UNDERLINE THE FINAL ANSWER.
- ANSWERS WITHOUT UNITS WILL BE IGNORED.

QUESTION 1

1.1 Discuss the common workpart transfer mechanisms used in automated production lines. (10)

1.2 A 14 station transfer line has been logged for 2 400 min to identify type of downtime occurrence, how many occurrences, and time lost. The results are presented in Table Q1. The ideal cycle time for the line is 0.50 min, including transfer time between stations.

Table Q1

Type of occurrence	Number	Time lost
Tool changes and failures	70	400 min
Station failures (mechanical and electrical)	45	300 min
Transfer system failures	25	150 min

Determine:

1.2.1 how many parts were produced during the 2 400 min; (4)

1.2.2 line uptime efficiency; (2)

1.2.3 average actual production rate per hour; and (2)

1.2.4 frequency ‘p’ associated with transfer system failures. (2)

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QUESTION 2

2.1 Discuss the components of a typical single station automated parts delivery system at a workstation. (10)

2.2 A six-station automatic assembly line has an ideal cycle time of 12 seconds. Downtime occurs for two reasons. First, mechanical and electrical failures cause line stops that occur with a frequency of once per 50 cycles. Average downtime for these causes is 3 minutes. Second, defective components also result in downtime. The fraction defect rate of each of the six components added to the base part at the six stations is 2%. The probability that a defective component will cause a station jam is 0.5 for all stations. Downtime per occurrence for defective parts is 2 minutes. Determine:

2.2.1 yield of assemblies that are free of defective components; (2)

2.2.2 proportion of assemblies that contain at least one defective component; (2)

2.2.3 average production rate of good product; and (2)

2.2.4 uptime efficiency. (2)

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QUESTION 3

3.1 Discuss the two basic components of a coordinate measuring machine. (2)

3.2 The operation of a machine vision system can be divided into three functions. Briefly describe each of the following functions:

3.2.1 image acquisition and digitization; (3)

3.2.2 image processing and analysis; and (3)

3.2.3 interpretation. (2)

3.3 A scanning laser deevice is used to measure the diameter of shafts that are ground in a centreless grinding operation. The part has a diameter of 12.065 mm with a tolerance of ±0.051 mm. The four sided mirror of the scanning laser beam device rotates at 250 rev/min. The collimating lens focuses 30^0 of the sweep of the mirror into a swath that is 25.4 mm wide. It is assumed that the light beam moves at a constant speed across ths swath. The photodetector and timing circuitry is capable of resolving time units as fine as 100 nanoseconds (100×10^{-9} seconds). This resolution should be equivalent to no more than 10% of the tolerance band (0.102 mm). Determine:

3.3.1 the interpretation time of the scanning laser beam for a part whose diameter is equal to the nominal size. (4)

3.3.2 the différence in interruption time is associated with the tolerance of ±0.051 mm. (2)

3.3.3 whether the resolution of the photodetector and timing circuitry sufficient to achieve the 10% rule on the tolerance band. (4)

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QUESTION 4

4.1 Compare and contrast the retrieval computer aided process planning and generative computer aided process planning. (6)

4.2 Explain three challenges to developement of a smoothly operating computer integrated manufacturing system. (6)

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QUESTION 5

5.1 Discuss activities associated with production control. (10)

5.2 A workaprt costing R80 is processed through the factory. The manufacturing lead time for the part is 12 weeks, and the total time spent in processing during the lead time is 30 hours for all operations at a rate of R35 per hour. Nonoperation costs total R70 during the lead time. The holding cost rate used by the company for work-in-progress is 26%. The plant operates 40 hours per week, 52 weeks per year. If this part is typical of the 200 parts per week processed throgh the factory, determine the following:

5.2.1 the holding cost per part during the manufacturing lead time; (2)

5.2.2 the total annual holding costs to the factory. (2)

5.2.3 If the manufaturing lead time were to be reduced from 12 weks to 8 weeks, how much would the total holding costs be reduced on an annual basis? (2)

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QUESTION 6

6.1 Discuss how autonomation assists in eliminating waste. (10)

6.2 The monthly usage for a component supplied to an appliance assembly plant is 5 000 parts. There are 21 working days in the month and the effective operating time of the plant is 450 minutes per day. Currently, the defect rate for the component is 2.2%, and the equipment used to produce the part is down for repairs an average of 22 minutes per day. Determine the takt time for this part. (4)

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TOTAL = 100

ANNEXURE

FORMULA SHEET

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

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

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

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

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

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

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

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:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$n_o = 2^B; \qquad MR = \frac{L}{n_o - 1} = \frac{L}{2^B - 1}$$

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

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

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

$$x + Ay + Bz + C = 0$$

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

$$R = L \cot A$$

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

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

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

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

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

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