UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACHELOR OF TECHNOLOGY *ENGINEERING : INDUSTRIAL*
SUBJECT	:	**PRODUCTION TECHNOLOGY IV**
CODE	:	**IPT411**
DATE	:	WINTER SSA EXAMINATION 20 JULY 2018
DURATION	:	(SESSION 2) 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

A 30 station transfer line presently operates with a line efficiency E = 0.45. The ideal cycle time = 1.4 minutes. The repair distribution is geometric with an average downtime per occurrence = 12 minutes, and each station has an equal probability of failure. It is possible to divide the line into two stages with 15 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 = 0.45 to E = 0.55.

[18]

QUESTION 2

A company is considering replacing one of the current manual workstations with an automatic workhead on a 10 station production line. The current line has six automatic stations and four manual stations. Current cycle time is 30 seconds. The limiting process time is at the manual station that is proposed for replacement. Implementing the proposal would allow the cycle time to be reduced to 24 seconds. The new station would cost R0.20/minute. Other cost data: C_w = R0.15/minute, C_{as} = R0.10/minute, and C_{at} = R0.12/minute. Breakdowns occur at each automated station with a probability 'p'= 0.01. The new automated station is expected to have the same frequency of breakdowns. Average downtime per occurrence T_d = 3.0 minute which will be unaffected by the new station. Material costs and tooling costs will be neglected in the analysis. Compare the current line with the proposed change on the basis of production rate and cost per piece. Assume a yield of 100% good product.

[12]

QUESTION 3

An industrial process can be depicted as in Figure Q3. Two components are made respectively, by operations 1 and 2, and then assembled together in operation 3. Scrap rates are as follows: q_1 = 0.20, q_2 = 0.1, and q_3 = 0. Input quantities of raw components at operations 1 and 2 are 25 000 and 20 000 respectively. One of each component is required in the assembly operation. Trouble is that defective components can be assembled just as easily as good components, so inspection and sortation is required in operation 4.

(Question 3 – continued)

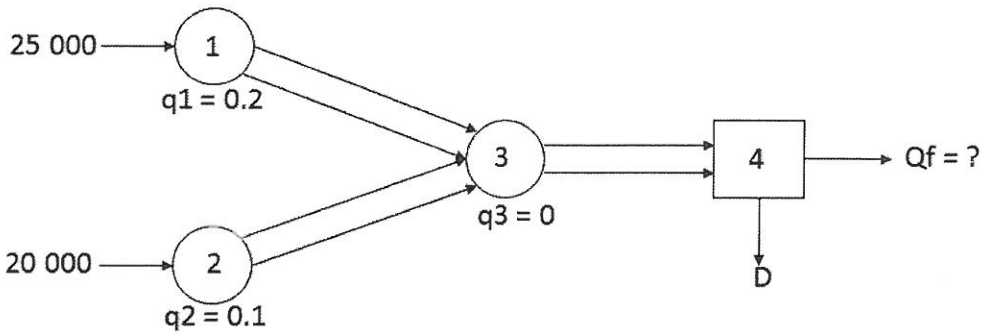

Figure Q3

Determine :

3.1 the number of defect-free assemblies that will be produced; (7)

3.2 the number of assemblies that will be made with one or more defective components; and (3)

3.3 whether there will be any leftover units of either component, and if so, how many ? (2)

[12]

QUESTION 4

Two of the edges of a rectangular part are represented by two lines in the x-y plane on a coordinate measuring machine (CMM) worktable. It is desired to mathematically redefine the coordinate system so that the two edges are used as the x- and y-axes, rather than the regular x-y axes of the CMM. To define the new coordinate system, two parameters must be determined : (a) the origin of the new coordinate system must be located in the existing CMM axis system ; and (b) the angle of the x-axis of the new coordinate system must be determined relative to the CMM x-axis. Two points on the first edge have been measured by the CMM and the coordinates are (46.21, 22.98) and (90.25, 32.50), where the units are mm. Also, two points on the second edge have been measured by the CMM and the coordinates are (26.53, 40.75) and (15.64, 91.12). The coordinates have been corrected for the radius of the probe. Determine:

4.1.1 the coordinates of the new origin relative to the CMM origin, and (16)

4.1.2 degrees of rotation of the new x-axis relative to the CMM x-axis. (3)

4.2 Are the two lines (part edges) perpendicular? (5)

[24]

QUESTION 5

Monthly usage rate for a certain part is 20 000 units. The part is produced in batches and its manufacturing costs are estimated to be R8.20. Holding cost is 18% of piece cost. Currently the production equipment used to produce this part is also used to produce 19 other parts with similar usage and cost data (assume the data to be identical for purposes of this problem). Changeover time between batches of the different parts is now 4.0 hours, and cost of downtime on the equipment is R275/hour. A proposal has been submitted to fabricate a fast-acting slide mechanism that will permit the chnagovers to be completed in just 5.0 minutes. Cost to fabricate and install the slide mechanism is R150 000.

5.1 Is this cost justified by the savings in total annual inventory cost that would be achieved by reducing the economic batch quantity from its current value based on a 4-hour setup to the new value based on a 5-minute setup? (18)

5.2 How many months of savings are required to pay off the R150 000 investment? (2)

[20]

QUESTION 6

6.1 Explain your understanding of computer-aided manufacturing. (4)

6.2 Discuss five benefits derived from computer-aided process planning. (10)

[14]

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:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$R = L \cot A$$

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

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

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

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

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

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