



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019**

COURSE NAME : PRODUCTION CONTROL
COURSE CODE : BBM 40402
PROGRAM CODE : BBA / BBD
DATE : JUNE / JULY 2019
DURATION : 2 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

THIS QUESTION PAPER CONSIST OF ELEVEN (11) PAGES

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Q1 (a) Name four (4) functional areas of an integrated manufacturing system. (4 marks)

(b) Explain the difference(s) between job enlargement and job enrichment by using an example. (6 marks)

(c) An industrial engineer at an automotive plant wishes to determine the standard time for vehicle front seat assembly process for their new hybrid car. The assembly process for front seats of each car is done by two operators: one operator for left seat assembly and another operator for right seat assembly. Using time study approach, and assuming car seats are assembled simultaneously by the two operators, the engineer has summarized his findings for 5 random cycles of assembly process in Table Q1(c).

Table Q1(c): Time Analysis for Door Assembly

No.	Work Elements	Cycle (Time in Seconds)				
		1	2	3	4	5
1	Seat holding and jig fixture	32	33	33	39*	32
2	Seat alignment	43	42	42	42	44
3	Bolt assembly	35	36	34	35	36

*Equipment Error

(i) Assume that work element 1 and 2 have 115% performance rating and work element 3 have 105% performance rating, calculate the standard time for the whole assembly operations if allowance factor is 10%. (7 marks)

(ii) With assumptions that the company has 20 full working days per month with 3 shifts daily (8 hours per shift) and, 4 working Saturday with 2 shifts only per month (8 hours per shift), estimate roughly the number of cars that can be assembled with completed front seat assembly per month. (4 marks)

(iii) Estimate the salary of a front seat assembly worker per shift if the cost for this assembly process per car is RM 0.80 using your estimation in Q1(c)(ii). (4 marks)



Q2 (a) Explain two (2) features of a good facility layout planning. (4 marks)

(b) The performance of an electrical switch assembly line in an electronic circuit manufacturing company is presented as below:

Table Q2(b): Assembly Line Process

Task	Follower	Performance Time (minutes)
A	B	0.2
B	E	0.2
C	D	0.8
D	F	0.6
E	F	0.3
F	G	1.0
G	H	0.4
H	-	0.3

(i) Draw a precedence diagram for this operation. (2 marks)

(ii) Assuming 8 hours of working per day, and daily production of 400 units of electrical switches, calculate the cycle time. (3 marks)

(iii) Calculate the theoretical minimum number of workstations. (3 marks)

(iv) Balance the assembly line by assigning tasks into workstations. What is the overall efficiency of this assembly line? (5 marks)

(c) A local distributor for a sport shoe company expects to sell approximately 8,000 shoes next year. Annual carrying cost is RM 3 per pair of shoes, and ordering cost is RM 30. The distributor operates 200 days a year.

(i) Calculate the economic order quantity (EOQ). (2 marks)

(ii) What is the expected number of orders? (2 marks)

(iii) Determine the time between orders. (2 marks)

(iv) Calculate the total annual cost if each pair of shoes cost RM 10. (2 marks)

Q3 (a) Explain two (2) implications of quality implementation. (4 marks)

(b) Explain two (2) types of inventory costing with examples. (6 marks)

(c) A quality control engineer is monitoring the performance of 20 production lines of a vehicle electronic module using computer vision inspection technology. The performance for each assembly line (measured using defects per 1,000 products) for a particular day is summarized as in Table Q3(c).

Table Q3(c): Defects Per Assembly Line

Line No.	Defects	Line No.	Defects
1	7	11	17
2	5	12	9
3	20	13	14
4	10	14	4
5	11	15	9
6	8	16	8
7	12	17	12
8	9	18	4
9	6	19	6
10	13	20	16

(i) Determine the upper control limit (UCL) and lower control limit (LCL) for a 99.73% (3-sigma) confidence level. (4 marks)

(ii) Plot a simple 3-sigma *p*-chart using information from Q3(c)(i) on graph paper. (8 marks)

(iii) Determine the assembly line(s) with unacceptable defect rates (if any) and provide evaluation on what should be done with the problematic assembly line(s). (3 marks)

Q4 (a) Indicate the concept of Kanban (or *pull*) production system using a simple illustration. (4 marks)

(b) An electrical appliance company has designed a new ceiling fan called "Sepoi S1" for budget-concerned home users. The product structure is as shown in Figure Q4(b) with numbers of components or subassemblies indicated. Lead time for each component is as shown in Table Q4(b).

Table Q4(b): Lead Time for Components

Lead Component	Lead Time (weeks)
Sepoi S1 (Ceiling Fan)	2
Blades	1
Fastener Set	1
Motor Sub-Assembly	2
Fan Motor	3
Fan Control Unit	2

(i) A production engineer is assigned to ensure that 500 units of the ceiling fan are to be ready by week 8. Generate the gross material requirements for this demand. (6 marks)

(ii) After a stock check, the engineer found that there are 300 units of blades, 400 units of fastener sets and 50 units of motor sub-assemblies. In order to meet 500 units of "Sepoi S1" demand in week 8, generate the net material requirements with consideration of current stock availability (*note: use the Net Requirement Planning Sheet on page 11 and attach to answer sheet*). (6 marks)

(c) Three jobs A, B, and C need to be processed by a lathe machine and a grinding machine. Every job is done by lathe machine followed by a grinding machine with processing time (in minutes) as shown in Table Q4(c).

Table Q4(c): Job Tasks for Machining Center

Job	Lathe Machine (min.)	Grinding Machine (min.)
A	2	5
B	8	8
C	6	12

(i) By using Johnson's rule, determine the best process sequence. (3 marks)

(ii) Sketch the sequence of two machines and determine the idling time. (6 marks)

-END OF QUESTIONS-

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER II / 2018/2019
SUBJECT NAME : PRODUCTION CONTROL

COURSE : BBA, BBD
SUBJECT CODE : BBM 40402

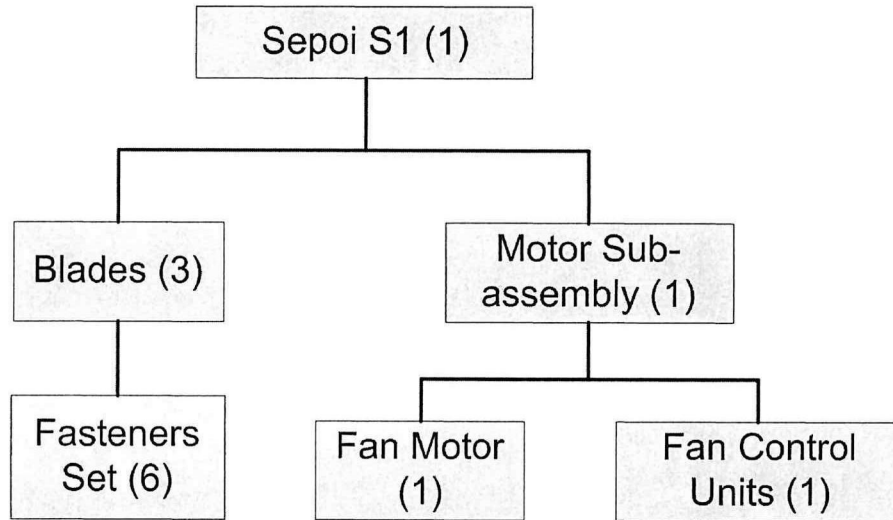


FIGURE Q4(b)

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER II / 2018/2019
 SUBJECT NAME : PRODUCTION CONTROL

COURSE : BBA, BBD
 SUBJECT CODE : BBM 40402

LIST OF FORMULA

Time Studies

Average observed time = (sum of times recorded) / number of observations

Normal time = (average observed time) x (performance rating factor)

Standard time = (total normal time) / (1 – allowance factor)

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}} = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n - 1}}$$

$$n = \left(\frac{z s}{h \bar{x}}\right)^2$$

n = Required sample size
 z = number of standard deviations required for desired level of confidence (from table)
 s = standard deviation of the initial sample
 \bar{x} = mean of sample size
 h = accuracy level desired in percent of the job element, expressed as decimal (5% = .05)

$$n = \frac{z^2 p(1-p)}{h^2}$$

n = Required sample size
 z = number of standard deviations required for desired level of confidence (from table)
 p = estimated value of sample proportion (of time worker is observed busy or idle)
 h = acceptable error level, in percentage decimals (5% = .05)

Process Layout Analysis

$$\text{minimize cost} = \sum_{i=1}^n \sum_{j=1}^n X_{ij} C_{ij}$$

n = total number of work centers or depts

i, j = individual departments

X_{ij} = number of loads moved from dept. i to dept. j

C_{ij} = cost to move a load between dept. i and dept. j

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER II / 2018/2019
 SUBJECT NAME : PRODUCTION CONTROL

COURSE : BBA, BBD
 SUBJECT CODE : BBM 40402

LIST OF FORMULA

Assembly Line Balancing

Cycle Time = Production time available per day / units required per day

$$\text{minimum workstations} = \frac{\sum_{i=1}^n T_i}{\text{cycle time}}$$

$$\text{Efficiency} = \frac{\sum \text{Task times}}{(\text{actual number of workstations}) \times (\text{Largest assigned cycle time})}$$

Inventory Control

$$EOQ = \sqrt{\frac{2DS}{H}}$$

Total Cost = Carrying costs + Ordering Costs + Purchase Costs

$$TC = \frac{QH}{2} + \frac{DS}{Q} + PD$$

D = Demand, S = Ordering Cost, H = Holding Cost, Q = units per order

Statistical Process Control: Mean Chart

Upper Control Limit (UCL) = $\bar{x} + z\sigma_{\bar{x}}$

Lower Control Limit (LCL) = $\bar{x} - z\sigma_{\bar{x}}$

\bar{x} = mean of the sample means or a target value set for the process

z = number of normal standard deviations (2 for 95.45%, 3 for 99.73%)

$\sigma_{\bar{x}}$ = standard deviation of the sample means = $\frac{\sigma}{\sqrt{n}}$

σ = population (process) standard deviation

n = sample size

Statistical Process Control: p- Chart

$$\sigma_{\bar{p}} = \sqrt{\frac{\bar{p}(1 - \bar{p})}{n}}$$

$$UCL_p = \bar{p} + z\sigma_{\bar{p}}$$

$$LCL_p = \bar{p} - z\sigma_{\bar{p}}$$

\bar{p} = mean fraction defective in sample

z = number of standard deviations (2 for 95.45%, 3 for 99.73%)

$\sigma_{\bar{p}}$ = standard deviation of the sampling distribution

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER II / 2018/2019
SUBJECT NAME : PRODUCTION CONTROL

COURSE : BBA, BBD
SUBJECT CODE : BBM 40402

LIST OF FORMULA

Job Sequencing

Average completion time = Sum of total flow time / Number of jobs

Utilization metric = Total job work (Processing Time) / Sum of total flow time

Average number of jobs in the system = Sum of total flow time / Total job work (processing) time

Average job lateness = Total late days / Number of jobs

Critical Ratio (CR) = Time Remaining / Workdays Remaining = (Due date – Today's Due) / Work time remaining

Just-In-Time Inventory & Scheduling

$$Q^* = \sqrt{\frac{2DS}{H[1 - (d/p)]}}$$

D = Annual Demand, S = Setup Cost, H = Holding Cost, d = Daily demand, p = Daily production

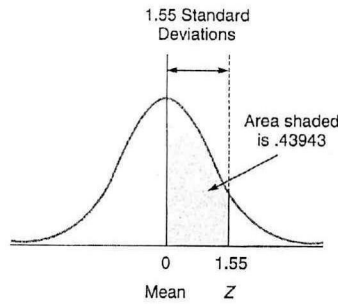
Number of Kanbans = (Demand during lead time + Safety Stock) / Size of container

FINAL EXAMINATION

SEMESTER / SESSION : SEMESTER II / 2018/2019
 SUBJECT NAME : PRODUCTION CONTROL

COURSE : BBA, BBD
 SUBJECT CODE : BBM 40402

NORMAL DISTRIBUTION TABLE



As an alternative to Table I.1, the numbers in Table I.2 represent the proportion of the total area away from the mean, μ , to one side. For example, the area between the mean and a point that is 1.55 standard deviations to its right is .43943.

TABLE I.2

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.00000	.00399	.00798	.01197	.01595	.01994	.02392	.02790	.03188	.03586
0.1	.03983	.04380	.04776	.05172	.05567	.05962	.06356	.06749	.07142	.07535
0.2	.07926	.08317	.08706	.09095	.09483	.09871	.10257	.10642	.11026	.11409
0.3	.11791	.12172	.12552	.12930	.13307	.13683	.14058	.14431	.14803	.15173
0.4	.15542	.15910	.16276	.16640	.17003	.17364	.17724	.18082	.18439	.18793
0.5	.19146	.19497	.19847	.20194	.20540	.20884	.21226	.21566	.21904	.22240
0.6	.22575	.22907	.23237	.23565	.23891	.24215	.24537	.24857	.25175	.25490
0.7	.25804	.26115	.26424	.26730	.27035	.27337	.27637	.27935	.28230	.28524
0.8	.28814	.29103	.29389	.29673	.29955	.30234	.30511	.30785	.31057	.31327
0.9	.31594	.31859	.32121	.32381	.32639	.32894	.33147	.33398	.33646	.33891
1.0	.34134	.34375	.34614	.34850	.35083	.35314	.35543	.35769	.35993	.36214
1.1	.36433	.36650	.36864	.37076	.37286	.37493	.37698	.37900	.38100	.38298
1.2	.38493	.38686	.38877	.39065	.39251	.39435	.39617	.39796	.39973	.40147
1.3	.40320	.40490	.40658	.40824	.40988	.41149	.41309	.41466	.41621	.41774
1.4	.41924	.42073	.42220	.42364	.42507	.42647	.42786	.42922	.43056	.43189
1.5	.43319	.43448	.43574	.43699	.43822	.43943	.44062	.44179	.44295	.44408
1.6	.44520	.44630	.44738	.44845	.44950	.45053	.45154	.45254	.45352	.45449
1.7	.45543	.45637	.45728	.45818	.45907	.45994	.46080	.46164	.46246	.46327
1.8	.46407	.46485	.46562	.46638	.46712	.46784	.46856	.46926	.46995	.47062
1.9	.47128	.47193	.47257	.47320	.47381	.47441	.47500	.47558	.47615	.47670
2.0	.47725	.47778	.47831	.47882	.47932	.47982	.48030	.48077	.48124	.48169
2.1	.48214	.48257	.48300	.48341	.48382	.48422	.48461	.48500	.48537	.48574
2.2	.48610	.48645	.48679	.48713	.48745	.48778	.48809	.48840	.48870	.48899
2.3	.48928	.48956	.48983	.49010	.49036	.49061	.49086	.49111	.49134	.49158
2.4	.49180	.49202	.49224	.49245	.49266	.49286	.49305	.49324	.49343	.49361
2.5	.49379	.49396	.49413	.49430	.49446	.49461	.49477	.49492	.49506	.49520
2.6	.49534	.49547	.49560	.49573	.49585	.49598	.49609	.49621	.49632	.49643
2.7	.49653	.49664	.49674	.49683	.49693	.49702	.49711	.49720	.49728	.49736
2.8	.49744	.49752	.49760	.49767	.49774	.49781	.49788	.49795	.49801	.49807
2.9	.49813	.49819	.49825	.49831	.49836	.49841	.49846	.49851	.49856	.49861
3.0	.49865	.49869	.49874	.49878	.49882	.49886	.49889	.49893	.49897	.49900
3.1	.49903	.49906	.49910	.49913	.49916	.49918	.49921	.49924	.49926	.49929

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Net Requirement Planning Sheets

Item	Period (Week, Day)											
	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement												
Scheduled Receipts												
Projected on Hand												
Net Requirements												
Planned Order Receipts												
Planned Order Releases												

Item	Period (Week, Day)											
	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement												
Scheduled Receipts												
Projected on Hand												
Net Requirements												
Planned Order Receipts												
Planned Order Releases												

Item	Period (Week, Day)											
	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement												
Scheduled Receipts												
Projected on Hand												
Net Requirements												
Planned Order Receipts												
Planned Order Releases												

Item	Period (Week, Day)											
	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement												
Scheduled Receipts												
Projected on Hand												
Net Requirements												
Planned Order Receipts												
Planned Order Releases												

Item	Period (Week, Day)											
	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement												
Scheduled Receipts												
Projected on Hand												
Net Requirements												
Planned Order Receipts												
Planned Order Releases												

Item	Period (Week, Day)											
	1	2	3	4	5	6	7	8	9	10	11	12
Gross Requirement												
Scheduled Receipts												
Projected on Hand												
Net Requirements												
Planned Order Receipts												
Planned Order Releases												

*Pencil written answers are acceptable on this sheet.