UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	INDUSTRIAL ENGINEERING
COURSE CODE	:	BDA 4012 / BDA 40102
PROGRAMME	:	BACHELOR'S DEGREE OF MECHANICAL ENGNEERING WITH HONOUR
EXAMINATION DATE	:	JUNE 2012
DURATION	:	2 HOURS
INSTRUCTIONS	:	ANSWER **All** QUESTIONS IN SECTION A AND ANY **TWO (2)** QUESTIONS FROM SECTION B

THIS QUESTION PAPER CONSISTS OF TEN (10) PAGES

Part A: Please answer <u>all questions</u> in this section.

Q1. (a) Describe the following 'facilities design' concepts (with an appropriate example):

(i) Product layout
(ii) Process layout

(5 marks)

(b) A manufacturing company is considering three locations - Senai (SN), Pasir Gudang (PG) and Pelabuhan Tanjung Pelepas (PTP) for a new plant. The company wishes to find the most economical location to meet an expected volume of 2,000 units per month at selling price of RM 150/unit. The fixed costs at each sites are RM 50,000, RM 150,000, and RM 250,000 respectively. The variable costs per unit are RM 75, RM 60, and RM 45 respectively.

(i) Plot the total cost curves for all the alternative locations on a single graph.
(4 marks)

(ii) Based on the optimal location, compute the expected profit for the expected volume of 2,000 units.
(4 marks)

(c) A toy racing car is assembled in mass production to meet customer demand 2,400 units per week. The assembly line is running 8 hours per day and 5 days per week. Details assembly data are summarized in **Table 1**.

Table 1: Assembly line information

Task	Performance Time (Sec)	Immediate Predecessors
A	30	None
B	18	A
C	24	B
D	18	A
E	36	D
F	30	C, E
G	12	F
H	36	G
I	6	F
J	24	F
K	24	J
L	42	H, I, K

(i) Draw a precedence diagram of this assembly operation.

(3 marks)

(ii) Determine the cycle time (in second).

(3 marks)

(iii) Based on grouping tasks into minimum numbers of workstations, calculate the line efficiency.

(6 marks)

Q2. (a) Given information as shown in the **Table 2** on job times and due dates, determine the optimal processing sequence using (1) FCFS, (2) SPT, and (3) EDD. For each method, find the:

(i) Average job flow time and the average job tardiness. Please decide which method is superior when lowest completion time becomes priority to the company.

(8 marks)

(ii) Which method is preferable when the shop is highly congested?

(2 marks)

Table 2: Operation time for different jobs

Job	Job Time (hours)	Due date (hours)
a	3.5	7
b	2.0	6
c	4.5	18
d	5.0	22
e	2.5	4
f	6.0	20

(b) Briefly explain what you understand on the following terminology related to ergonomics:

(i) Anthropometrics
(ii) Biomechanics
(iii) Work physiology

(9 marks)

(c) Ergonomics is the application of scientific information concerning humans to the design of objects, systems and environment for human use. Please discuss **three (3)** important factors to be considered when designing ergonomic workstations for factory.

(6 marks)

Part B: Please answer any <u>two (2)</u> out of three (3) questions provided in this section.

Q3. (a) Please state **four (4)** inputs needed to develop a material requirements plan (MRP).

(4 marks)

(b) Develop a material requirements plan for component H. Lead times for the end item and each component except B are one week. The lead time for B is three weeks. Sixty units of X are needed at the start of week 8. The product structure tree for X is shown in **Figure Q3** (Refer Appendix 1). There are currently 15 units of B on hand and 130 of E on hand, and 50 units of H are in production and will be completed by the start of week 2.

(15 marks)

(c) ABC Plumbing stocks large quantity of plumbing items to regional plumbers, contractors and retailers. The general manager is thinking to revise the order quantity and hoping that some money could be saved annually if EOQ were used instead of the firm's present rule of thumb. He conducts an analysis of one material only i.e a brass T-join to see if significant savings might results from using EOQ. Given that demand, D = 10,000 valves per year, Q = 400 valves per order based on present order, holding cost = RM0.40 per valve per year and ordering cost = RM5.50 per order. The firm is operating 250 days in a year and production rate = 120 unit. Find the annual cost saving.

(6 marks)

Q4. (a) Installing mufflers at the Ingress Auto Venture plant, Selangor involves five work elements. An engineer at the plant has timed workers performing these tasks seven times, with the results shown in the **Table 3**. The company practiced fatigue allowance of 7%, personal allowance of 8%, 8 hour work per day, 1 shift, 24 days per month and average worker's wage of RM7.00 per hour.

(i) Compute the standard time in min for the installation work.

(4 marks)

(ii) If the company is requested to install 10,000 units muffler per month, suggest the number of operators needed.

(3 marks)

(iii) If only 60% of the employee is willing to work over time, compute the average overtime per hour per operator per day must be arranged in order to meet 10,000 units monthly demand of muffler if the company only capable of employing 35 operators.

(6 marks)

Table 3: Time Study Data

	Observations (minutes)							Performance Rating (%)
Job Element	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
1. Select correct mufflers	4	5	4	6	4	15[a]	4	110
2. Inspect and clean muffler	6	8	7	6	7	6	7	90
3. Weld/install the muffler	15	14	14	12	15	16	13	105
4. Check/inspect work	3	4	24[a]	5	4	3	18[a]	100
5. Complete paperwork	5	6	8	25[a]	7	6	7	130

[a]Employee has lengthy conversations with boss (not job related)

(b) IT Suria is a large computer discount store that sells computers, ancillary equipment and software in the town where Universiti Kebangsaan Malaysia is located. It has collected historical data on computer sales for the past 10 years as shown in **Table 4**.

Table 4: Yearly computer sales

Year	Personal Computer Sales
1	1045
2	1610
3	860
4	1211
5	975
6	1117
7	1066
8	1310
9	1517
10	1246

(i) Forecast sales for year 11 using each of the following:

(a) A linear trend equation.
(b) A five-year moving average.
(c) Exponential smoothing with a smoothing constant equal to = 0.2, assuming a year 4 forecast of 1260.
(d) 6-month weighted average using 0.1, 0.1, 0.1, 0.2, 0.2 and 0.3, with the heaviest weights applied to the most recent months.

(12 marks)

Q5. (a) Describe the following 'quality control' concepts:

(i) Quality Hierarchy
(ii) Six Sigma

(5 marks)

(b) In mass production of metal component, Shewhart control chart is used for monitoring process condition. The inspection samples (x-bar) of the related process variables are summarized in **Table 5**.

Table 5 : Inspection samples for the process feature (in mm)

Sample no. : 1 ~ 20	Sample no. : 21 ~ 40	Note
7.9430	7.9410	
7.9425	7.9420	
7.9415	7.9435	Specification:
7.9420	7.9415	Ø 7.942 ± 0.004
7.9415	**7.9425**	
7.9430	7.9435	Sample standard deviation
7.9420	7.9415	(σ_{xbar}) = 0.001
7.9435	7.9420	
7.9425	7.9425	
7.9415	**7.9415**	
7.9425	7.9400	
7.9435	7.9405	
7.9420	7.9400	
7.9410	7.9390	
7.9425	**7.9400**	
7.9415	7.9390	
7.9410	7.9385	
7.9420	7.9380	
7.9430	7.9385	
7.9420	**7.9380**	

(i) Predict the initial process capability.

(5 marks)

(ii) If sample no. 1 ~ 20 can be assumed as a historical set of data which is represents a statistically in-control process, determine the process mean (central line, μ) and control limits (UCL, LCL) of the Shewhart control chart (Refer Table 6 in Appendix II).

(9 marks)

(iii) Plot the Shewhart control chart for sample no. 21 ~ 40. Suggest which areas to be in a statistically "in-control" and "out-of-control" conditions (provide your answers based on range of samples).

(6 marks)

Appendix I

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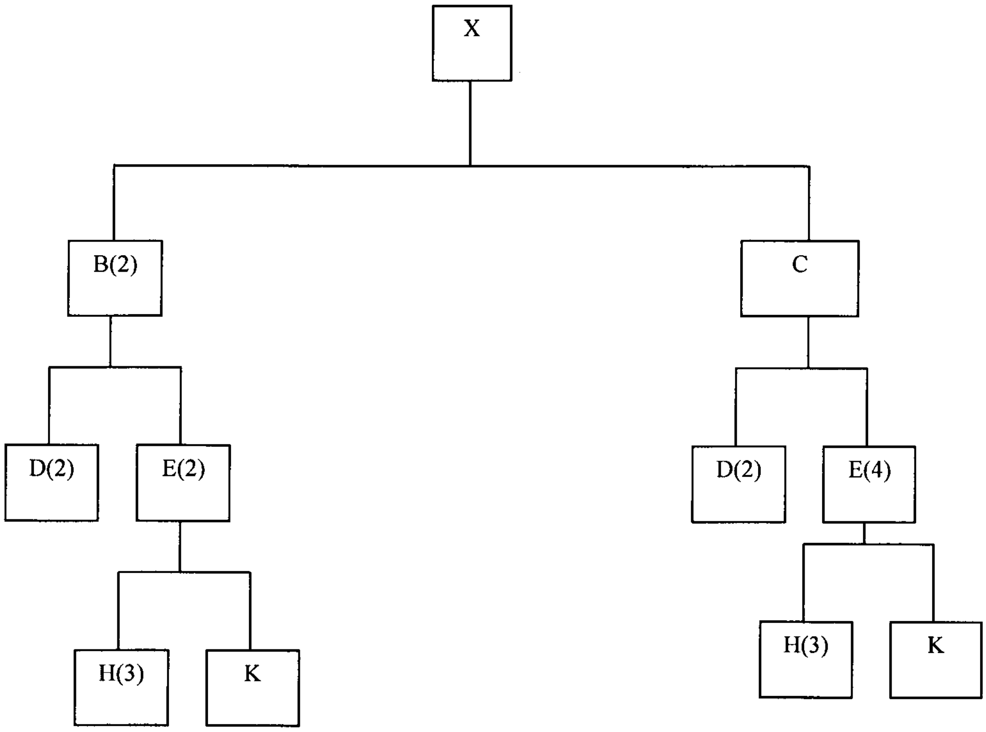

FIGURE Q3: Product structure tree for X

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Table 6: Factors for Computing Central Lines and 3σ Control Limits for $\overline{X}$, s and R Charts.

OBSERVATIONS IN SAMPLE, n	CHART FOR AVERAGES: FACTORS FOR CONTROL LIMITS			CHART FOR STANDARD DEVIATIONS: FACTOR FOR CENTRAL LINE	CHART FOR STANDARD DEVIATIONS: FACTORS FOR CONTROL LIMITS				CHART FOR RANGES: FACTOR FOR CENTRAL LINE	CHART FOR RANGES: FACTORS FOR CONTROL LIMITS				
	A	A_2	A_3	c_4	B_3	B_4	B_5	B_6	d_2	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	0	3.267	0	2.606	1.128	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	0	2.568	0	2.276	1.693	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	0	2.266	0	2.088	2.059	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	0	2.089	0	1.964	2.326	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	0.030	1.970	0.029	1.874	2.534	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	0.118	1.882	0.113	1.806	2.704	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	0.185	1.815	0.179	1.751	2.847	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	0.239	1.761	0.232	1.707	2.970	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	0.284	1.716	0.276	1.669	3.078	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	0.321	1.679	0.313	1.637	3.173	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	0.354	1.646	0.346	1.610	3.258	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	0.382	1.618	0.374	1.585	3.336	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	0.406	1.594	0.399	1.563	3.407	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	0.428	1.572	0.421	1.544	3.472	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	0.448	1.552	0.440	1.526	3.532	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	0.466	1.534	0.458	1.511	3.588	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	0.482	1.518	0.475	1.496	3.640	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	0.497	1.503	0.490	1.483	3.689	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	0.510	1.490	0.504	1.470	3.735	0.729	1.549	5.921	0.415	1.585