UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER I
SESSION 2020/2021

COURSE NAME	:	INDUSTRIAL ENGINEERING
COURSE CODE	:	DAM 22103
PROGRAMME CODE	:	DAM
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	1) ANSWER **FIVE (5)** QUESTIONS ONLY. 2) THE ANSWER BOOKLET NEED TO BE SUBMITTED **15 MINUTES** AFTER THE EXAMINATION END. (SUBMIT ALL THE DOCUMENTS IN PDF)

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) The Sahabat Manufacturing Sdn Bhd owns three respective factories in Sepang, Penang and Ipoh, which have been distributing products to the retail shops in three states namely Johor Bahru, Negeri Sembilan and Kuala Lumpur. **Table 1** summarizes factory availabilities, projected store demands and unit shipping cost (in RM). Calculate the minimum shipment cost for distributing the product.

(10 marks)

Table 1: Data of factory availabilities, projected store demands and unit shipping cost (in RM)

Factory location	Shops location			Supply (units)
	Johor Bahru	Negeri Sembilan	Kuala Lumpur	
Sepang	4	3	2	35
Penang	6	7	8	50
Ipoh	8	1	5	50
Demand (units)	30	65	40	135

(b) **Table 2** gives the map coordinates and the shipping loads for a set of cities that Sentiasa Jaya Enterprise wish to connect through a central distribution hub. Assume that, the cost per unit movement are the same within both places.

Table 2: Coordinates & shipping loads

City	Map coordinate (x,y)	Shipping load
A	(5,10)	5
B	(6,8)	10
C	(4,9)	15
D	(9,5)	5
E	(7,9)	15
F	(3,2)	10
G	(2,6)	5

i) Compute the optimum location for this central hub.

(7 marks)

ii) If the cost is RM2.50/distance, calculate the total cost for this optimum location.

(3 marks)

Q2 A work study was conducted for a process which involves 6 work elements consecutively. **Table 3** shows the process cycle time in minutes, taken by stop watch using 'snap back' technique. A worker's salary is RM 2,000 per month. The allowances given are 5 % for fatigue, 6 % for delay, and 7 % for personal relief.

Table 3: The process cycle time in minutes

Work Elements	Assembly Methods	Rating	Cycle Time (minutes)				
			1	2	3	4	5
A	Manual	90%	5.0	4.3	4.5	4.8	4.6
B	Manual	85%	12.3	13.4	10.0	14.5	13.0
C	Automatic		4.0	4.0	4.0	4.0	4.0
D	Manual	110%	8.9	7.7	9.0	9.3	8.6
E	Manual	115%	15.8	14.6	17.3	18.0	16.7
F	Automatic		6.0	6.0	6.0	6.0	6.0

i) Calculate the standard time for the whole assembly process.

(5 marks)

ii) If the demand is 10,000 units per month, estimate the number of operators required for the assembly process. The company is operating 20 days per month and a single 8 hour shift per day.

(5 marks)

iii) If the company willing to employ 50 workers, estimate the overtime cost per day for each worker for the production of 10,000 units per month. Assume only 80 % workers are available for overtime and the overtime pay rate is 2 times of the normal wage.

(10 marks)

Q3 Forecasting is the method of estimating the amount of customer future demand in order for product to be supplied. Referring to **Table 4**, forecast the demand in October using the following methods;

Table 4: Demand for product to be supplied

Month	Demand
January	23
February	19
Mac	20
April	22
May	22
June	18
July	25
August	23
September	22
October	F_{Oct}

i) Naive method

(2 marks)

ii) 4 – period simple moving average

(3 marks)

iii) Simple exponential smoothing with $\alpha = 0.3$. Assume the forecast for month of June is 21

(5 marks)

iv) Using regression technique, forecast the demand for month of October and December.

(10 marks)

Q4 A salt packaging company managed to collect a total of 20 subgroup of size n=4 from its packaging process. **Table 5** shows the weight in kg of the sample. Factors for control limit are given in **Table 6** (*see appendix*). Illustrate X-bar and R control charts for the salt packaging process and give some comment on the process performance.

(20 marks)

Table 5: Weight of salt

No of Subgroup	Weight of salt (kg)			
	X1	X2	X3	X4
1	4.6	1.0	2.0	4.5
2	3.8	3.0	2.0	5.0
3	3.6	2.9	2.9	1.8
4	4.4	1.9	3.8	3.8
5	2.5	2.8	3.5	3.6
6	1.9	4.9	3.7	3.2
7	1.6	7.0	4.9	4.0
8	4.0	3.2	3.6	7.0
9	3.0	4.4	2.9	1.8
10	3.1	2.6	3.4	2.0
11	3.8	1.5	2.5	2.6
12	2.0	2.4	3.6	3.5
13	2.2	2.2	3.3	2.1
14	3.8	4.0	1.8	4.1
15	2.5	2.5	3.6	3.6
16	2.2	4.1	2.1	3.1
17	3.8	4.6	3.2	2.0
18	2.1	2.5	2.1	3.7
19	3.0	3.0	2.0	2.6
20	3.3	3.2	2.1	2.8

Q5 (a) **Table 7** represents the frequency of paint defects from an automotive assembly plant.

Table 7: Frequency of paint defects

Paint Defect	Frequency
Orange Peel	12
Sealer Under Dirt in Paint	4 65
Thin Paint	5
Off-Color	2
Sag	21
Scratch	3
Other	1

i) Calculate the percentage of total and cumulative percentage for each defect.

(4 marks)

ii) Sketch the Pareto Chart to identify the major problem of paint defects.

(6 marks)

(b) A manufacturing company has an assembly line consists of 3 machines and 4 types of jobs, as shown in **Table 8**. The production manager has two (2) optional sequences which are S4-S1-S3-S2 and S3-S1-S2-S4. Interpret which one is a better job sequence based on total makespan and idle time.

(10 marks)

Table 8: Processing time

Machine	Processing time (hour)			
	S1	S2	S3	S4
A	1	3	8	3
B	6	2	5	4
C	5	3	1	2

Q6 **Figure Q6** illustrates the Bill of Materials for product A. The Master Production Schedule for product A calls for 100 units in week 2, 150 units in week 5, and 200 units in week 7. The lead times for components B, and D are 1 week, and for the other components the lead time is 2 weeks. No safety stock is required for components B, C, D, E, F and G. The L4L lot-sizing rule is used for components B, E and G; the POQ lot-sizing rule (P=3) is used for component D. Component F has an FOQ of 250 units, and C has an FOQ of 100 units. On hand are 50 units of B, 50 units of C, 200 units of D, 50 units of E, and 300 units of F. Component B and G has a scheduled receipt of 50 units in week 1. Based on your analysis;

i) Develop a material requirements plan for component G.

(10 marks)

ii) Develop a material requirement plan for component F.

(10 marks)

- - END OF QUESTION -

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Formula:

$$TC = FC + VC(Q)$$

$$f(x,y) = \sum_{i=1}^{n} w_i \left(|x - a_i| + |y - b_i|\right) \rightarrow Minisum\ formula$$

$$\left.\begin{array}{l} f(x,y) = max(|x - a_i| + |y - b_i|) \\ First\ point: (x_1, y_1) = 0.5(c_1 - c_3\ , c_1 + c_3 + c_5) \\ Second\ point: (x_2, y_2) = 0.5(c_2 - c_4\ , c_2 + c_4 - c_5) \end{array}\right\} Minimax\ formula$$

$$Normal\ time = \frac{(Total\ observation\ time)x(Productive)x(Rating)}{Total\ Output}$$

$$a = \frac{\sum y - b\sum x}{n} \qquad b = \frac{n\sum(xy) - \sum x \sum y}{n\sum x^2 - \left(\sum x\right)^2}$$

$$Q^* = \sqrt{\frac{2DS}{H}} \qquad TC = \frac{D}{Q}S + \frac{Q^*}{2}H$$

$$Q^* = \sqrt{\frac{2DS}{H(1 - d/p)}} \qquad TC = \frac{D}{Q}S + \frac{Q^*}{2}H*(1 - d/p) \qquad d = \frac{D}{\text{working days / year}}$$

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Table 6

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

OBSERVATIONS IN SAMPLE, n	CHART FOR AVERAGES: FACTORS FOR CONTROL LIMITS A	A_2	A_3	CHART FOR STANDARD DEVIATIONS: FACTOR FOR CENTRAL LINE c_4	FACTORS FOR CONTROL LIMITS B_3	B_4	B_5	B_6	CHART FOR RANGES: FACTOR FOR CENTRAL LINE d_2	FACTORS FOR CONTROL LIMITS d_1	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

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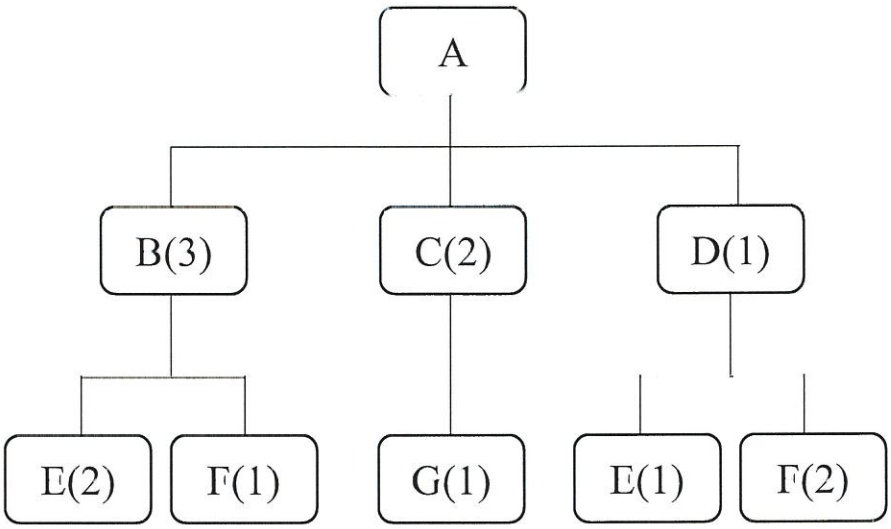

Figure Q6: Bill of materials for Product A