清大工工系 109 學年度第 2 學期設施規劃期末考

NTHU IEEM 109-2 midterm examination of facility planning

注意事項/Notes：

1. 請於 **4 月 23 日晚上 10 點前**完成期中考，並透過電子郵件將 **PDF 檔案**寄送予授課教師。逾期則視為未出席期中考，且分數以零分計算。

   Please complete your midterm examination and send your **PDF file** to the teacher by email **before 22:00 on April 23 (Friday)**. If the file is sent after the deadline, the status of your final exam will be considered as not attending the exam and the score will be calculated as zero points.

2. 期中考的繳交時間是以授課教師信箱收到信件的時間為準，並非修課同學將信件寄出的時間。因此，請將電子郵件可能會延遲寄送的因素納入考量，提早寄送期中考的檔案。

   The submission time of your midterm exam files is the time when the teacher 's mailbox receives the letter, not the time when the classmates send the letter. Therefore, considering that email may be delayed, please send the midterm exam files early.

3. 「電子郵件標題」與「檔案的檔名」為均「**學號-姓名**」。

   E-mail title and file name are both **"Student ID"-"Name"**.

4. 作答方式可以用電腦打字，也可以手寫後掃描。

   Answer files can be formed by typing on a computer or scanned after handwriting.

5. 每位同學所使用的數字均不同，請參考附檔。數字使用錯誤將不給分。

   The numbers used by each classmate are different. Please refer to the attached file. No points will be awarded for incorrect use of numbers.

6. 頁數若不夠作答，請自行延伸。

   If there are not enough pages to answer, please extend this DOCX file yourself.

姓名/Name：_____ 學號/Student ID：_____

一、（5%）請依流程動線圖之原則繪製一張工廠之「流程動線圖」。其中，至少三種產品之加工路線在圖內。

(5%) Please draw a “flow diagram” of the factory according to the principle of the flow diagram. Among them, there are at least three product processing routes in the diagram you drew.

回答：/Answer:

表 1、流程動線圖/

Table 1: Flow diagram

流程動線圖之實例/Example of the flow diagram

二、在某工廠內，有進貨區、出貨區，以及 5 個工作站。工廠之主力產品為工具箱，工廠內之工作站佈置順序為「R-**(1)-(2)-(3)-(4)-(5)**-S」，工具箱所需零件之編號與數量如表 2 所示。再者，各零件之重量與加工途程如表 3 所示。該工廠被要求每天需生產**(6)**個工具箱，請依序回答下列問題。

In a factory, there are a receiving area, a shipping area, and 5 workstations. The main product of the factory is the toolbox, and the arrangement order of these 5 workstations in the factory is "R-**(1)-(2)-(3)-(4)-(5)**-S". The number and quantity of the parts required by the toolbox are shown in Table 2. The weight and processing route of each part are shown in Table 3. The factory is required to produce **(6)** toolboxes every day. Please answer the following questions in order.

表 2、工具箱之零件清單/

Table 2: BOM of a toolbox

編號	1	2	3	4	5	6	7	8	9
用量	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**

表 3、工具箱零件之重量與加工途程/

Table 3: Weight and processing route for the toolbox parts

編號 /No.	重量(公斤)/ Weight (Kg.)	加工途程/ Processing Route
1	**(16)**	R→**(25)**→**(26)**→**(27)**→**(28)**→S
2	**(17)**	R→**(29)**→**(30)**→**(31)**→**(32)**→**(33)**→S
3	**(18)**	R→**(34)**→**(35)**→**(36)**→**(37)**→S
4	**(19)**	R→**(38)**→**(39)**→**(40)**→**(41)**→**(42)**→S
5	**(20)**	R→**(43)**→**(44)**→**(45)**→**(46)**→S
6	**(21)**	R→**(47)**→S
7	**(22)**	R→**(48)**→**(49)**→**(50)**→**(51)**→S
8	**(23)**	R→**(52)**→**(53)**→**(54)**→S
9	**(24)**	R→**(55)**→S

1. （5%）為達工廠所設定之生產目標，請計算各工作站每天的產量。
(5%) In order to achieve the production target, set by the factory, please calculate the daily output of each workstation.

答案：/Answer:

表 4：工作站的每日產量/

Table 4: Daily output of workstations

工作站/ Workstation	每日需加工數量（件/天）/ Daily Processing Quantity (Pieces/Day)
A	
B	
C	
D	
E	

計算過程：/Calculation Process:

2. （10%）各工作站由數個相同的機台所組成，如工作站 A 由 4 台機台 A 所構成。各機台對各零件之標準加工能力（件/小時）如表 5 所示。假設，每日工作時間為**(56)**小時，各機台之平均稼動率為**(57)%**，人員對該機台之操作效率為**(58)%**。採無條件進位法，請計算各工作站之需求機台數量。
(10%) Each workstation is composed of several identical machines, for example, Workstation A is composed of 4 Machines A. The standard processing capacity (pieces/hour) of each machine for each part is shown in Table 5. Assuming that the daily working time is **(56)** hours, the average utilization rate of each machine is **(57)** %, and the operating efficiency of the personnel on the machine is **(58)** %. Using the unconditional carry method, please calculate the number of machines required for each workstation.

表 5、機台對零件之加工能力/
Table 5: Processing capacity of the machine for parts

機台/ Machine	零件/Part								
	1	2	3	4	5	6	7	8	9
A	**(59)**	**(60)**	**(61)**	**(62)**	**(63)**	**(64)**	**(65)**	**(66)**	**(67)**
B	**(68)**	**(69)**	**(70)**	**(71)**	**(72)**	**(73)**	**(74)**	**(75)**	**(76)**
C	**(77)**	**(78)**	**(79)**	**(80)**	**(81)**	**(82)**	**(83)**	**(84)**	**(85)**
D	**(86)**	**(87)**	**(88)**	**(89)**	**(90)**	**(91)**	**(92)**	**(93)**	**(94)**
E	**(95)**	**(96)**	**(97)**	**(98)**	**(99)**	**(100)**	**(101)**	**(102)**	**(103)**

答案：/Answer:

表 6、工作站之機台數量/
Table 6: Number of machines for each workstation

工作站/ Workstation	機台/ Machine	實際機台數量（台）/ Actual Number of Machines (Item)
A	A	
B	B	
C	C	
D	D	
E	E	

計算過程：/Calculation Process:

3. （10%）在此工廠內，進貨區面積為**(104)**平方公分，出貨區面積為**(105)**平方公分。另外，各機台的長度、寬度，以及所需之人員操作面積、物料存放面積如表 7 所示。假設，除進貨區出貨區外，通道、死角等面積為工作站面積之**(106)%**。請計算工廠之需求面積。

(10%) In this factory, the area of the incoming goods area is **(104)** square centimeters, and the area of the outgoing area is **(105)** square centimeters. In addition, the length and width of each machine, as well as the required personnel operating area and material storage area are shown in Table 7. Assume that, except for the incoming and outgoing area, the area of aisles and dead ends is **(106)**% of the area of the workstation. Please calculate the required area of this factory.

表 7、機台、人員與物料之面積/

Table 7: Area of machines, personnel, and materials

機台/ Machine	長度（公分）\ Length(cm)	寬度（公分）\ Width(cm)	人員操作面積\（平方公分/台）\ Personnel operator Area (cm^2/Item)	物料儲存面積\（平方公分/台）\ Material Storage Area (cm^2/ Item)
A	**(107)**	**(112)**	**(117)**	**(122)**
B	**(108)**	**(113)**	**(118)**	**(123)**
C	**(109)**	**(114)**	**(119)**	**(124)**
D	**(110)**	**(115)**	**(120)**	**(125)**
E	**(111)**	**(116)**	**(121)**	**(126)**

回答：/Answer:

表 8、工廠面積/

Table 8: Area of this factory

工廠面積（平方公分）/ Factory Area (cm^2)	

計算過程：/Calculation Process:

4. （10%）各工作站的距離如表 9。正向懲罰權重為「**(127)**」，逆向懲罰權重為「**(128)**」。將搬運零件重量、數量，以及工作站距離納入考量，以從至分析法計算目前工作站之佈置效率。

(10%) The distance between each workstation is shown in Table 9. The forward penalty weight is "**(127)**", and the reverse penalty weight is "**(128)**". Take part weight, quantity, and workstation distance into consideration. Please use the from-to-analysis method to calculate the current workstation layout efficiency.

表 9、工作站間之距離（公尺）/

Table 9: Distance between workstations (meters)

距離/ Distance	R	A	B	C	D	E	S
R		**(129)**	**(130)**	**(131)**	**(132)**	**(133)**	**(134)**
A			**(135)**	**(136)**	**(137)**	**(138)**	**(139)**
B				**(140)**	**(141)**	**(142)**	**(143)**
C					**(144)**	**(145)**	**(146)**
D						**(147)**	**(148)**
E							**(149)**
S							

回答與計算過程：/Answer and calculation process:

表 10、無懲罰值之零件總流動量（現在佈置）/

Table 10: Total traffic flow without penalty for all parts in the current layout

Flow	R						S
R							
S							

表 11、有懲罰值之零件總流動量（現在佈置）/

Table 11: Total traffic flow with penalty for all parts in the current layout

Flow	R						S
R							
S							

佈置效率：\Layout Efficiency:_____

5. （10%）於此佈置中，各工作站間之作業關聯為何呢？。
(10%) In this current layout, what is the operating relationship between the workstations?

回答：\Answer:

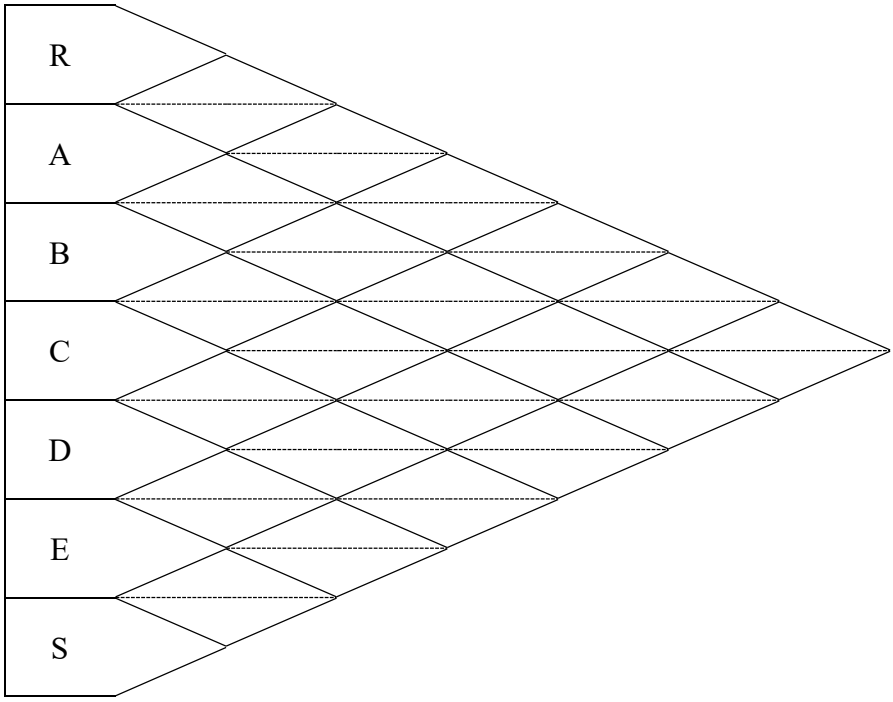
表 12、作業關聯之等級/

Table 12: Workstation relationship level

等級\Level	下限/Lower limit	上限/Upper limit
A		
E		
I		
O		
U		

表 13、/作業關聯表

Table 13: Operation relationship between the workstations



計算過程：/Calculation Process:

6. （10%）請提出工作站的改善方案，請計算此改善後工作站佈置效率。
(10%) Please propose an improvement layout for the workstation and calculate the efficiency of the workstation layout after this improvement.

A. 改善方案/：Improvement Layout: R-____-____-____-____-____-**S**

回答：/Answer:

表 14、無懲罰值之零件總流動量（改善佈置）/
Table 14: Total traffic flow without penalty for all parts in the improvement layout

Flow	R						S
R							
S							

表 15、有懲罰值之零件總流動量（改善佈置）/
Table 15: Total traffic flow with penalty for all parts in the improvement layout

Flow	R						S
R							
S							

佈置效率：\Layout efficiency:_____

計算過程：/ Calculation Process:

7. （5%）請計算所提出工作站佈置的改善效率。

(5%) Please calculate the improved rate of the proposed workstation layout.

改善率：\Improvement rate:_____

三、在清華醫院之診間內，有位醫師在看診。病患進入醫院與報到後，就到診間外等待。之後，病患依序進入診間看診。若醫師還在看診，病患則繼續在外等待。待醫師看完診後，病患即可離開診間。假設病患編號、來到間隔時間、診療時間如表 16 所示。請計算至小數點以下第二位。

In Tsinghua Hospital, there is a doctor in the office room. After entering the hospital and registering, the patient waits outside the clinic. After that, the patients enter the clinic in order. If the doctor is still serving the previous patient, the patient will continue to wait outside. After the doctor finishes his service, the patient can leave the clinic. The patient number, time interval between arrivals, and treatment time are as shown in Table 16. Please count to the second decimal place.

表 16、病患之抵達間隔時間與診療時間/

Table 16: Arrival interval time and treatment time of patients

病患編號 Patient No.	來到間隔時間 Arrival Interval Time	診療時間 Treatment Time
1	**(150)**	**(156)**
2	**(151)**	**(157)**
3	**(152)**	**(158)**
4	**(153)**	**(159)**
5	**(154)**	**(160)**
6	**(155)**	**(161)**

1. （2.5%）請計算病患在系統內之平均停留時間。
(2.5%) Please calculate the average stay time of the patient in the system

2. （2.5%）請計算病患在候診間內之平均停留時間。
(2.5%) Please calculate the average stay time of the patient in the waiting room

3. （2.5%）請計算候診間之平均等候時間（等候線之平均長度）。
(2.5%) Please calculate the average waiting time in the waiting room (average length of waiting line).

4. （2.5%）請計算醫生之平均忙碌率或使用率。
(2.5%) Please calculate the average busy rate or utilization rate of doctors.

四、（5%）請依你個人經驗提出一項物料搬運作業之實例，並依 5W1H 物料搬運方程式分析此實例。

(5%) Please propose an example of material handling operations based on your personal experience. After that, please analyze this example according to the 5W1H material handling equation.

表 18、物料搬運作業之實例/

Table 18: Examples of material handling operations

物料搬運作業之實例/Examples of material handling operations

表 19、物料搬運方程式之分析

Table 19: Analysis of material handling equation

5W1H	內容/Content
Why	
What	
Where	
Who	
When	
How	

五、本學期修課心得以及課程建議。

Please write down your experiences and suggestions for the current semester.

1. （加分，2.5%）修課心得

(Bonus, 2.5%) Lessons learned

2. （加分，2.5%）課程建議

(Bonus, 2.5%) Course feedback