

Prince of Songkla University  
The Faculty of Engineering

Midterm Examination Semester 2

Year 2009

Date : 22 December 2009

Time :13.30-16.30

Subject : 226-341 Maintenance Engineering

Room : R300

Name : .....

Student code : .....

**คำสั่ง**

1. นำกระดาษ A4 ที่เขียนด้วยลายมือตนเองเข้าได้ 1 แผ่น เขียนได้หน้า-หลัง ห้ามปะกระดาษอื่นเพิ่มเติมในกระดาษ A4
2. ห้ามใช้ดินสอ และ ห้ามยืมเอกสารหรือสิ่งของใดๆในห้องสอบ
3. นำ Dictionary และ เครื่องคิดเลขเข้าห้องสอบได้ ทุกชนิด (ห้ามบันทึกข้อความที่เกี่ยวข้องกับวิชานี้)
4. ข้อสอบนี้ คะแนนแต่ละส่วนไม่เท่ากัน ตรวจสอบก่อนเริ่มทำ *(ให้ทำในกระดาษคำตอบเท่านั้น ตอบนอกกระดาษคำตอบไม่มีคะแนน)*
5. เขียน ชื่อ หรือ รหัส ในกระดาษคำตอบทุกหน้าก่อนเริ่มทำ เพื่อป้องกันความสับสนในกรณีกระดาษคำตอบหลุดจากฉบับ
6. ข้อสอบมีทั้งหมด 12 หน้า แบ่งออกเป็น 2 ส่วนๆ ละ 50 คะแนน นักศึกษาควรใช้เวลาในแต่ละส่วนไม่เกิน 1.5 ชม.

ทูลจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น  
และพักการเรียน 1 ภาคการศึกษา



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**ส่วนที่ 1 ผศ.ดร.กลางเดือน โพนนา**

Question	1	2	3	Total
<b>Full score</b>	<b>10</b>	<b>10</b>	<b>30</b>	<b>50</b>
Score				

**Question 1** Answer all questions. Please determine whether these following sentences are correct or incorrect. One point (1 point) will be given for the right answer. Minus half point (-0.5 point) will be given for the wrong answer. (Total 10 points)

Q no. 1.	Correct ✓	Incorrect ✗	Question
1			Periodic maintenance is the maintenance activity that involves with the measurement and monitoring of machine deterioration parameter by using specific devices.
2			One of the differences between preventive maintenance and maintenance prevention is number of operators used.
3			Predictive maintenance relates to the consistent monitoring of important parameters of machine.
4			The chance of machine failure of modern machine with high automatic control is normally higher than the failure chance in old fashioned machine.
5			Maintenance engineering activity normally starts after the machine is installed in the factory.
6			TPM is one of maintenance type that includes management commitment of top manager.
7			In BM system, a plant must be stopped at regular basis for special check.
8			The letter "S" in the objective of production management, "PQCDSMEE", means "Specification".
9			Preventive maintenance is very important in the infant stage of machine.
10			Lubrication is one of the activities in preventive maintenance and self maintenance.

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**Question 2.** How does this subject (226-341 Maintenance Engineering) relate to the following subjects? Please explain clearly. (2 points each, total 10 points)

1. Plant layout
2. Work study (Motion and time study)
3. Safety and Environmental Engineering
4. Quality Control
5. Engineering Economy



**Question 3.** Match the following descriptions with the given types of maintenance. (30 points)

**Maintenance types:**

- A. Breakdown Maintenance
- B. Preventive Maintenance
- C. Corrective Maintenance
- D. Productive Maintenance
- E. Maintenance Prevention
- F. Predictive Maintenance
- G. Periodic Maintenance
- H. Total Productive Maintenance
- I. Autonomous Maintenance

**Questions:**

	Maintenance Type	Description
1		The maintenance that takes action when machine runs to failure.
2		The maintenance that is normally called "Maintenance free".
3		The people who operate the equipment are trained in and are responsible for daily and weekly maintenance activity. Tasks such as daily lubrication , inspection of hoses and cables ,and weekly checks on the tightness and adjustment of various components are the responsibility of production associates.
4		Maintenance type that focuses on the initial design of equipment to reduce the amount of maintenance required.
5		Equipment with design weakness must be redesigned to improve reliability or improving maintainability
6		It is an innovative Japanese concept. Nippondenso was the first company to introduce this maintenance system.
7		The routine maintenance of equipment would be carried out by the one who uses machine.
8		Details studies of components, materials, and quality led to the improvement of machine at the design stage.
9		The overall costs of the equipment's life cycle are considered. The preventive cost is compared with failure cost.



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	<b>Maintenance Type</b>	<b>Description</b>
10		It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.
11		It improves equipment and its components so that preventive maintenance can be carried out reliably.
12		Weakness of current machines are sufficiently studied ( on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing ) and are incorporated before commissioning a new equipment.
13		Maintenance that aims to eliminate chronic causes of failures.
14		Maintenance that relates to 5 senses inspection by operator.
15		Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.
16		The maintenance that aims for cost decreasing throughout machine life cycle.
17		Retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance.
18		This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life.
19		A major goal of this maintenance, apart from lengthening the life of equipment, is total elimination of all losses and total participation of all employees.
20		The maintenance that involves small group activities.
21		The aim of this maintenance is to maximize plant and equipment effectiveness to achieve optimum life cycle cost of production equipment.
22		To reduce or eliminate maintenance problem through an equipment change or by changing a process.

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	<b>Maintenance Type</b>	<b>Description</b>
23		Consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.
24		The maintenance that aims to improve reliability or maintainability of machine. This maintenance normally follows the step of problem solving.
25		The maintenance that requires the operators to learn some routine maintenance functions while the more sophisticated procedures are reserved for technicians.
26		When a facility subsists in a reactive mode, they are using this maintenance. That is, a workplace essentially runs its equipment until it stops working.
27		The maintenance that aims for removal of chronic failure of machine.
28		This calls for the improvement of equipment and its components so that preventive maintenance can be reliably carried out. Includes upgrades that would extend the machine's longevity or increase production quality.
29		A central idea in this maintenance is the concept of self-directed maintenance, wherein machine operators are responsible for the routine maintenance and operations of their machines and equipment.
30		The maintenance that involves machine diagnosis technology.



I wish you Happiness and Joy...  
And Blessings for the New Year 2010,

Good Luck,

Dr. Klangduen Pochana.

ส่วนที่ 2 ผศ.ดร.ชเนศ รัตนวิไล

Question	1	2	3	4	Total
Full score	12	12	12	14	50
Score					

**Question 1.** In a small furniture factory, the list of machines is shown in table 1. Same type of machine is replaceable with different reliability.

Table 1 List of machine in the small furniture factory

Type of machine	Machine code	Reliability
1. Turning machine	T1	0.90
2. Turning machine	T2	0.80
3. Turning machine	T3	0.70
4. Drilling machine	D1	0.90
5. Drilling machine	D2	0.95
6. Parting machine	P1	0.70

- 1.1 To produce the table leg as shown in figure 1, three main processes have to be operated. Design the production line and calculate to have the highest reliability. (6 points)
- 1.2 How to increase your system reliability in 1.1 to reach 95%. Show your calculation. (6 points)

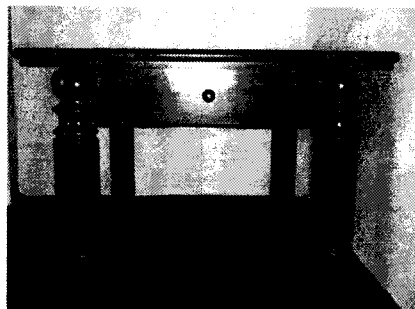
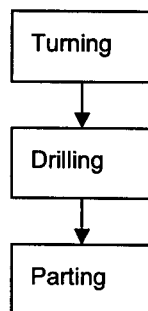


Figure 1 Flow process of table leg

**Question 2.** Seven components have been tested for a period of 90 hours as shown in table 2 and the average downtime is 60 hours, calculate (12 points)

Table 2 Number of item-hour tested

Hours before failure (hours)	Number of failure
30	1
40	2
45	1
60	3

- 2.1 Reliability at the first hour of operation
- 2.2 Reliability at MTBF
- 2.3 Time interval (hours) to maintain reliability greater than 75%
- 2.4 Availability for this item





**Question 3.** Figure 3 shows system reliability as a function of number of components. When  $n=30$ ,

3.1 Calculate your answer into the table and draw a line into figure 3. Show your calculation in details. (8 points)

3.2 Explain the meaning of figure 3 (4 points)

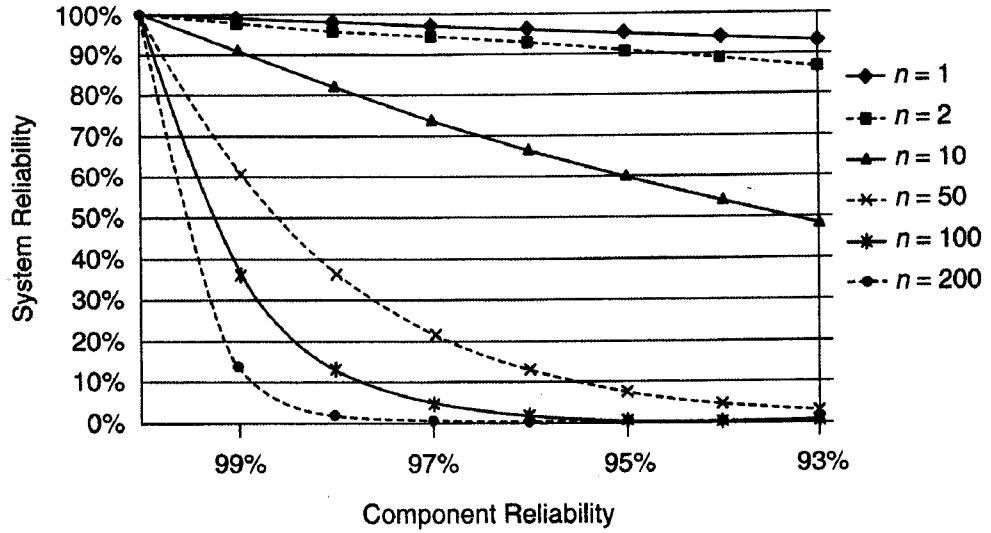


Figure 3 System reliability as a function of number of components

Table 3 System reliability at  $n=30$

Component reliability	System reliability
99%	.....
97%	.....
95%	.....
93%	.....

**Question 4.** An electrical factory has a working time from 8 am to 5 pm on Monday to Saturday. There is an one hour for lunch time and 15 minute breaks in the afternoon. Time study on an assembly line has shown that a consistent production rate of 20 second per part can be achieved. For several reasons, it was found that about 155 parts per day are rejected. After asking the employees, they recalled that a safety switch stuck for about 6 minutes after lunch and has to examine the product every 15 minutes for 2 minutes each time. .

4.1 Calculate OEE. (8 points)


%A = .....  
 %P = .....  
 %Q = .....  
 OEE = .....

4.2 How to increase the OEE value in 4.1 to be greater than 100%? (2 points)

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4.3 Calculate TEEP (4 points)


**%A** = .....  
**%P** = .....  
**%Q** = .....  
**TEEP** = .....

Good Luck,  
Dr. Thanate Ratanawilai

