Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	PACKAGING INDUSTRIAL MAINTENANCE
COURSE CODE	:	BNK 30103
PROGRAMME CODE	:	BNK
EXAMINATION DATE	:	JUNE / JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

Q1 (a) As a new maintenance engineer in an industrial plant, you are assigned to develop maintenance procedures for chain drive. Prepare an outline for chain drive maintenance procedures.

(8 marks)

(b) Name the type of gear in **Figure Q1(b),** elaborate on how it works and propose an application of this gear.

(5 marks)

(c) A SKF Explorer 6309 deep groove ball bearing is to operate at 2500 rpm under a constant radlal load Fr – 10 kN. The desired reliability is 90% and it is assumed that the operating conditions are very clean. If the basic dynamic load rating of the bearing C is 55.3 kN, determine the basic rating life 90% of this bearing, L_{10} and L_{10h}.

(7 marks)

(d) Discuss what failure's type of bearing in the **Figure Q1(d)** by giving the probable causes to the defect and recommend the appropriate solutions.

(5 marks)

Q2 (a) Misalignment is one of a major concern that affects the life of drive belt. Categorize the type of misalignment and elaborate on how it reduces the life of drive belt.

(5 marks)

(b) While inspecting the packaging machinery, Farid heard a slapping noise that comes from the drive belt at the packaging machine. Diagnose the problem by providing the probable causes and solution to remove the noise.

(5 marks)

(c) While inspecting a gearbox at a packaging machine. A maintenance engineer found the gear with the damage as shown in **Figure Q2(c)**. Diagnose the defect and predict the probable causes and recommend solutions to avoid the defect from reappearing.

(5 marks)

(d) Elaborate the basic applications of chain drive and give examples for those applications.

(5 marks)

(e) It is required to drive a shaft in **Figure Q2(e)** at 720 revolutions per minute (RPM), by means of a belt from a parallel shaft, having a pulley A 300 mm diameter on it and running at 240 revolutions per minute (RPM). What size pulley is required for the shaft B.

(5 marks)

Q3 (a) **Figure Q3(a)** shows a defect impeller of a centrifugal pump. Diagnose the defect by providing the process that cause the defect and suggest ways to mitigate the problem.

(6 marks)

(b) Tiang is working as a plant engineer in a carton box manufacturing plant. His routine work is to turn on a series of pump in the plant every morning. However, some pumps that he turned on did not give sufficient discharge. Diagnose the problem by providing possible causes of this failure and suggest ways to avoid the failure from recurring.

(6 marks)

(c) As a maintenance engineer, you are assigned to develop a lubrication program in a plant. Prepare an outline that needs to be considered in developing the program.

(7 marks)

(d) Determine the next time the lubrication of ball bearing need to be done if the bearing is working under temperature between 175 F to 200 F and surrounded with light contamination non-abrasive dust at humidity condition between 80 to 90 %. In addition, it vibrates at less than 0.3 ips velocity peak at and is positioned at 45 degree bore centerline. The bore diameter of the bearing is 50 mm and rotates at 2500 rpm.

(6 marks)

Q4 (a) There are **THREE** (3) types of clearance in the bearing. Elaborate the clearance that are applied at the bearing and explain the consequence if there is insufficient clearance in the bearing.

(5 marks)

(b) Power consumption of rotating equipment in a plant is 30 Megawatts. By doing proper alignment on all of these equipment to a smaller tolerance, it is expected to reduce the power consumption by 0.75%. Calculate the savings that might be gained by the plant through the plant wide shaft alignment exercise? Assume the electricity price is RM 0.45/kWh and the plant is running for 6 days/week for 52 weeks.

(5 marks)

(c) **Figure Q4(c)** shows one of the techniques of shaft alignment. Identify the technique and explain the advantageous and disadvantageous of this technique.

(5 marks)

(d) **Figure Q4(d)** illustrates the technique of removing the bearing from the shaft, elaborate on the technique and explain the advantage of using the technique in removing bearing.

(5 marks)

(e) Differentiate between the dynamic pumps and positive displacement pump and list at least three sub pumps for each type.

(5 marks)

Q5 (a) Machines that operate at a considerably hotter or colder condition than the ambient room temperature should be thermally compensated in term of shaft alignment, which is called thermal growth. Discuss this scenario and provide the best way to know about the thermal growth in the machine.

(5 marks)

(b) Farid had found through statistic that the coupling of several pumps in the plant had frequently failed. Analyze the problem and give at least four reasons for the recurring problems.

(6 marks)

(c) An engineer has to determine which lifting sling has the required safety weight limit (SWL). He has to examine the SWL for grade 80 Lifting sling with 10 mm diameter, grade 60 lifting chain with 10 mm diameter, and Flexible Steer Wire Roper (FSWR) with 10 mm diameter. Evaluate all three slings and select which sling is appropriate to be used if the load that needs to be lifted is 3 tones.

(8 marks)

(d) One of very important procedure to start a centrifugal pump is priming. Explain why does this pump require priming and provide two ways on how the priming can be done.

(6 marks)

Q6 (a) By inspecting the following **Figure Q6(a),** diagnose the failure of the mechanical seals by proposing the type of failures and the probable causes for the failure.

(5 marks)

(b) Compressor is one of the least efficient machinery in an industrial plant. Suggest and justify at least **FIVE (5)** methods to reduce the energy consumption by the compressor.

(5 marks)

(c) **Figure Q6(c)** shows a multistage compressor. Multi stage compressor is proven to have used less energy in comparison with single stage compressor. Point out why the multi stage compressor is more efficient in energy consumption by referring to the image.

(5 marks)

(d) Hairul is one of the operator in an industrial plant. One of his job is to move heavy material in the plant using crane. Advice Hairul on what he should checked before lifting and before landing the material.

(5 marks)

(e) Total Based Number (TBN) and Total Acid Number (TAN) are useful oil properties that indicate the condition of the oil. Differentiate TBN and TAN and explain how they help in indicating the condition of oil.

(5 marks)

-END OF QUESTION-

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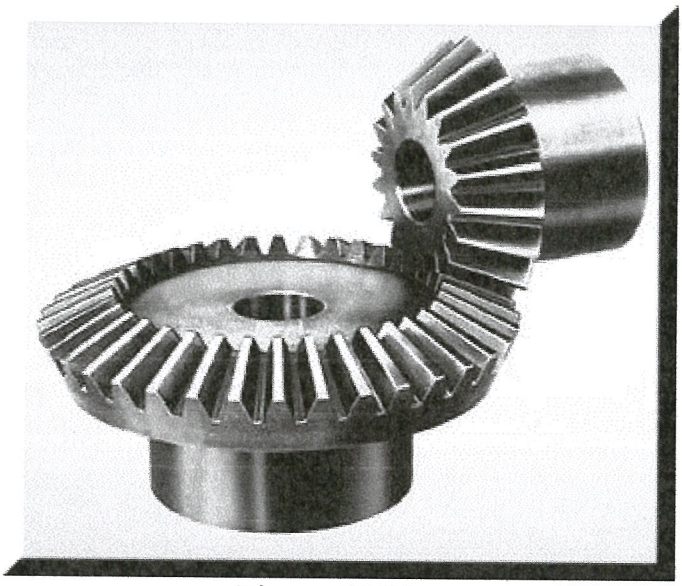

Figure Q1(b)

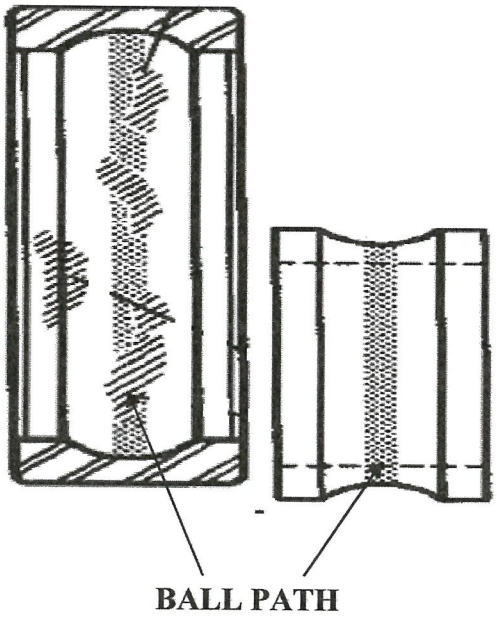

Figure Q1 (d)

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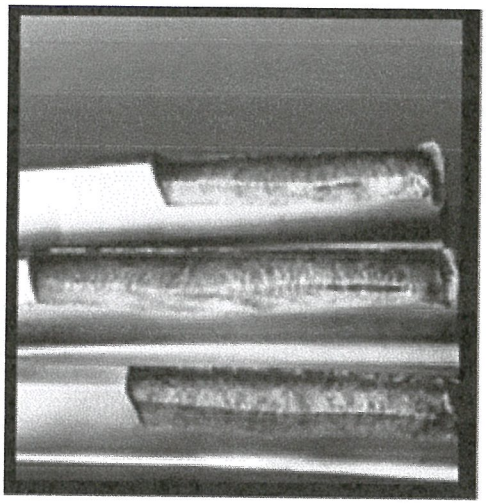

Figure Q2(c)

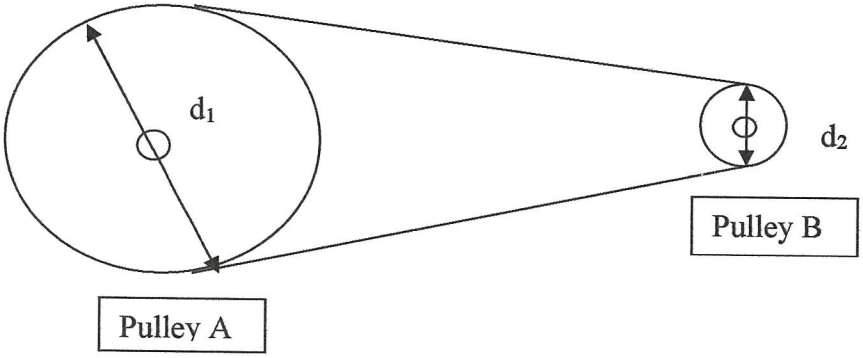

Figure Q2(e)

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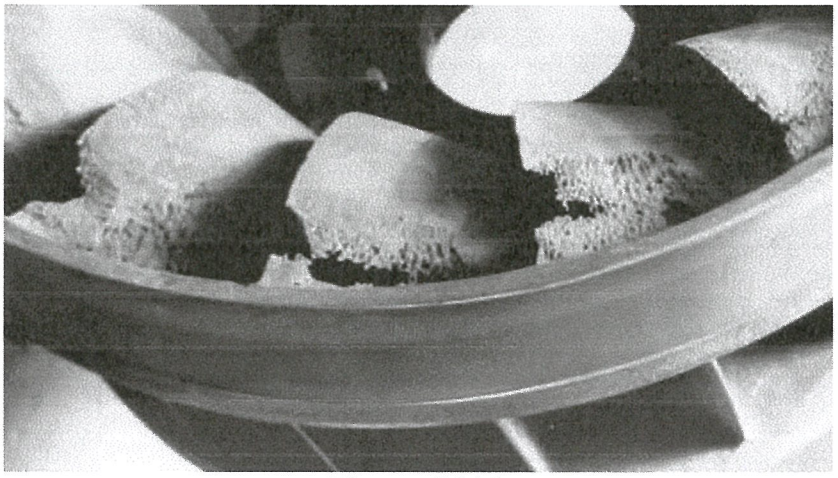

Figure Q3(a)

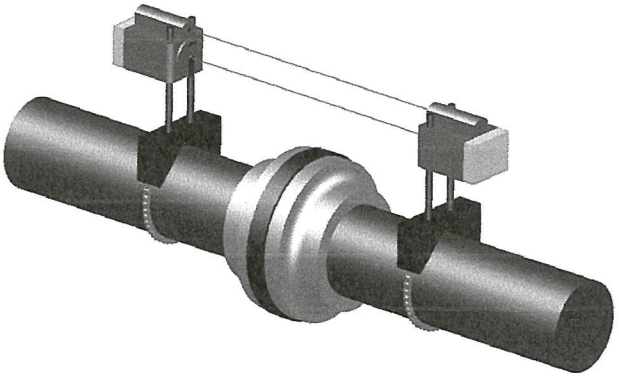

Figure Q4 (c)

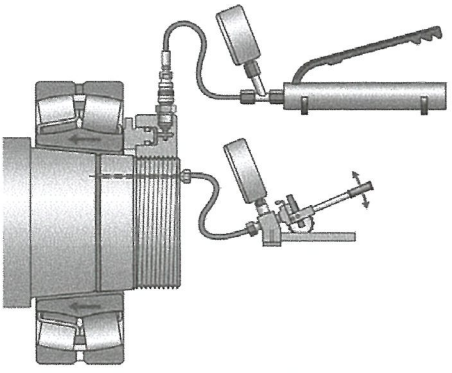

Figure Q4 (d)

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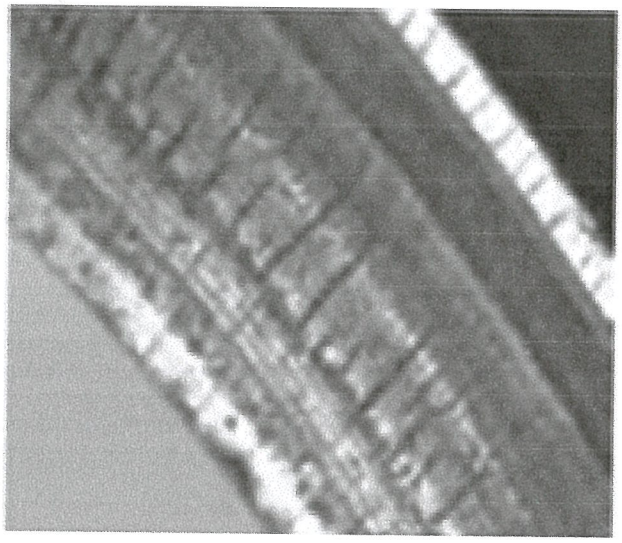

Figure Q6(a)

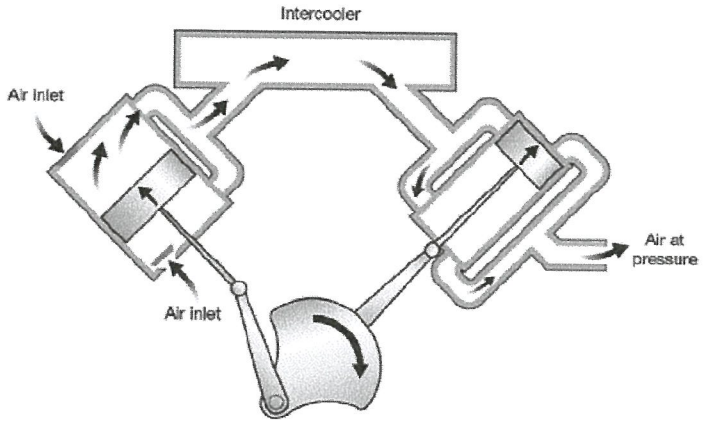

Figure Q6(c)

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FORMULA and TABLES

$$T = K \times \left[\left(\frac{14{,}000{,}000}{n \times (d^{0.5})} \right) - 4 \times d \right]$$

Where:

T = Time until next relubrication (hours)

K = Product of all correction factors
Ft x Fc x Fm x Fv x Fp x Fd
(see table)

n = Speed (RPM)

d = Bore diameter (mm)

Note:
ips = inches / second
0.2 inches / second = 5 mm / sec.

Grease Interval Correction Factors

Condition	Average Operating Range	Correction Factor
Temperature Ft	Housing below 150°F	1.0
	150 to 175°F	0.5
	175 to 200°F	0.2
	Above 200°F	0.1
Contamination Fc	Light, non-abrasive dust	1.0
	Heavy, nonabrasive dust	0.7
	Light, abrasive dust	0.4
	Heavy, abrasive dust	0.2
Moisture Fm	Humidity mostly below 80%	1.0
	Humidity between 80 and 90%	0.7
	Occasional condensation	0.4
	Occasional water on housing	0.1
Vibration Fv	Less than 0.2 ips velocity, peak	1.0
	0.2 to 0.4 ips	0.6
	Above 0.4 (see note)	0.3
Position Fp	Horizontal bore centerline	1.0
	45 degree bore centerline	0.5
	Vertical centerline	0.3
Bearing Design Fd	Ball bearings	10
	Cylindrical and needle roller bearings	5.0
	Tapered and spherical roller bearings	1.0

Bearing load

1. **Dynamic equivalent radial load**

   $Pr = XFr + YFa$

2. **Life 90%**

   a. $L10 = (C/P)^P$ p=3 for ball bearing, p=10/3 for roller bearing

   b. $L_{10h} = (10^6 / 60n)L_{10}$